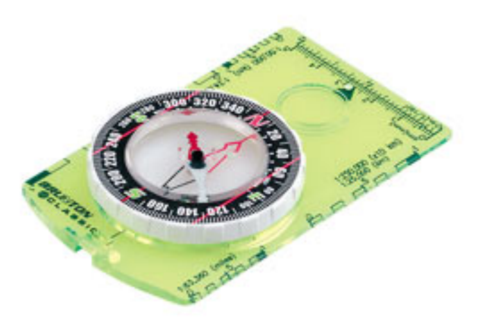
RANDALL'S ADVENTURE TRAINING ®
LAND NAVIGATION

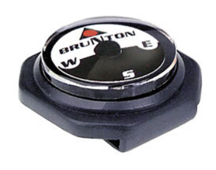
This Course Consists Of:

- Compass Basics
- Orienting a Map For North Reference
- Traveling to a Target
- Backstops, Handrails and Aiming Off
- Topo Map Basics
- Pace Counting
- Finding Yourself
- UTM Coordinate System
- Using GPS with a Map
- Understanding And Adjusting For Declination

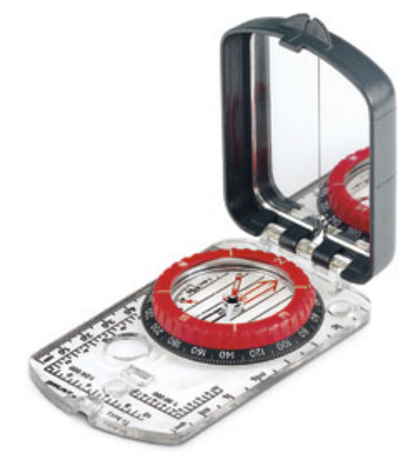
Compass Types



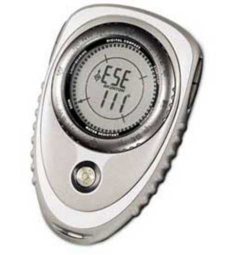
Baseplate



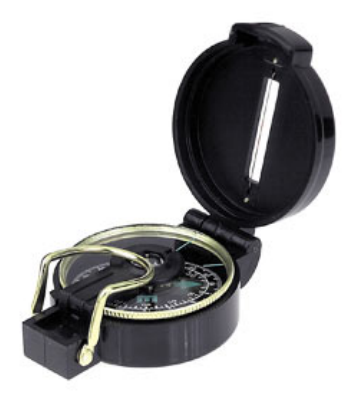
Accessory



Mirrored – Sighting (Preferred)

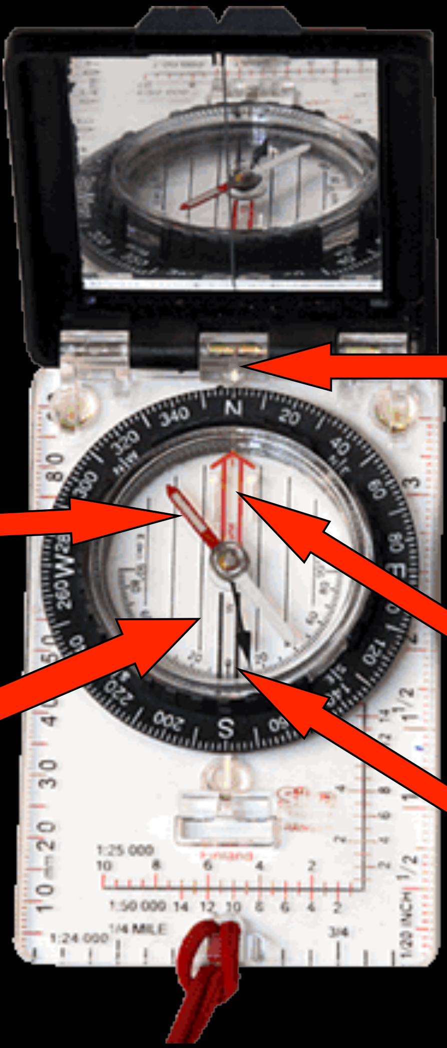


Digital



Lensatic

LAND NAVIGATION



Bearing Index (Read Bearing Here)

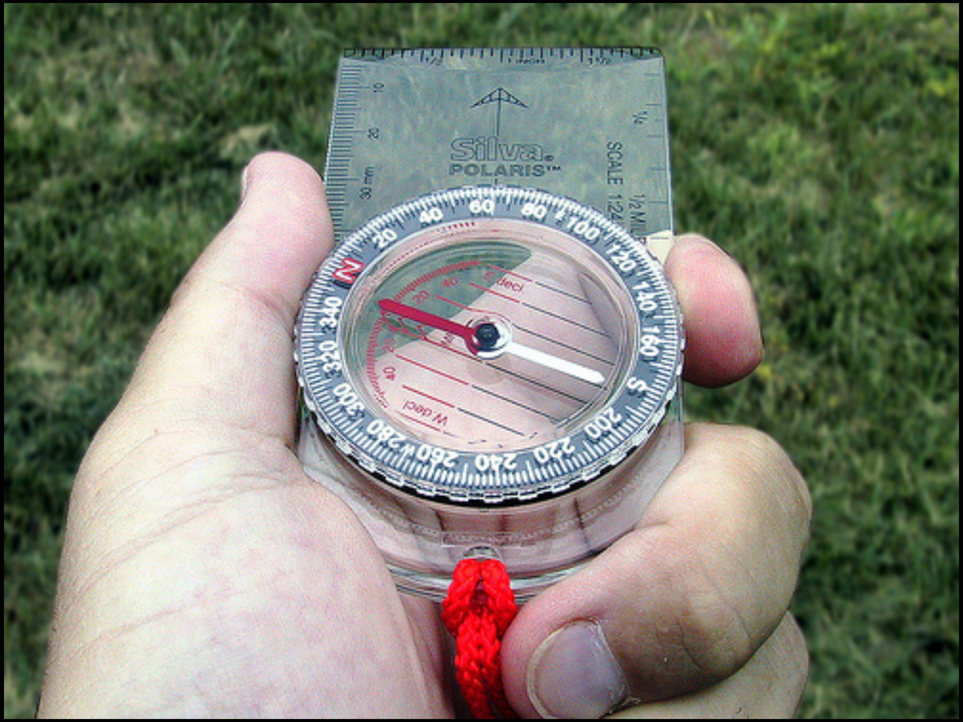
Compass Needle – Red Points To Magnetic North

Orienting Arrow

Orienting Lines

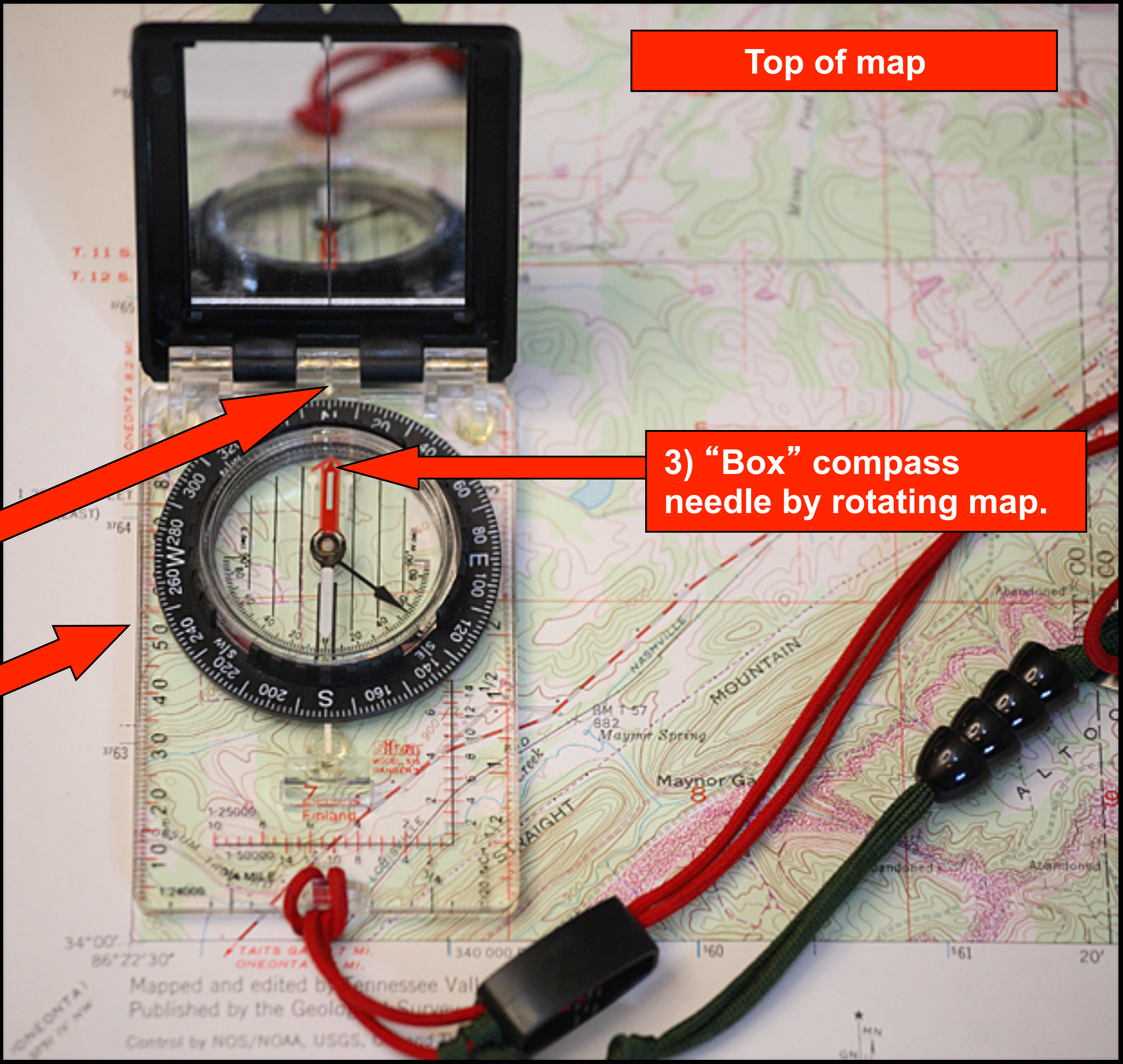
Declination Scale

Boxing A Compass



MAP ORIENTATION

With Compass Adjusted For Declination


N
20
300
W280
260
240
220
200
S
160
140
120
100
E
80
60
MOUNTAIN
NASHVILLE
STRAIGHT
Maynor Spring
Maynor Ga
Finland
Abandoned
34°00'
86°22'30"
Mapped and edited by Tennessee Vall
Published by the Geolo

Top of map

1) Adjust dial so "N" is at index line.

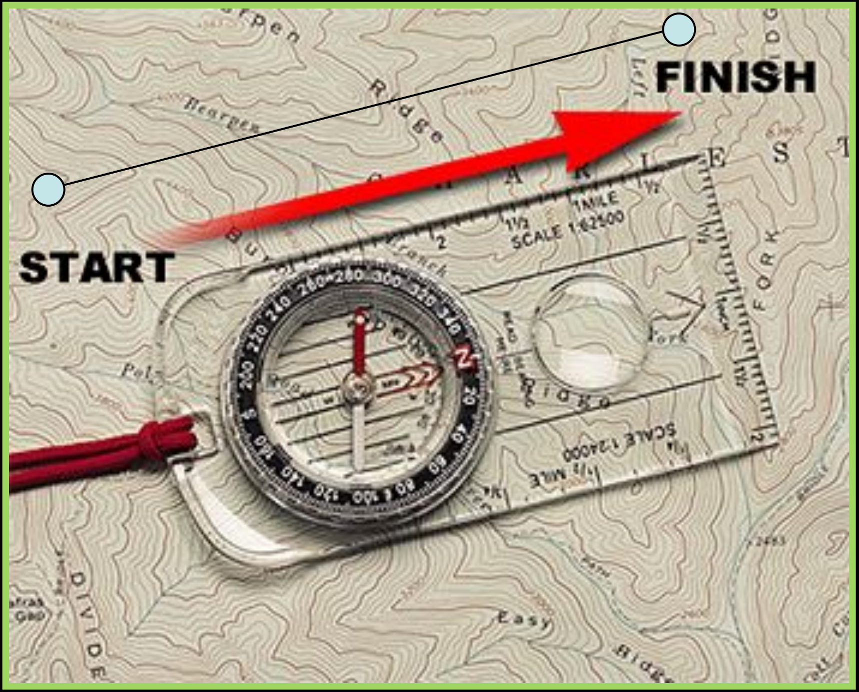
2) Align edge of compass with north / south reference line.

3) "Box" compass needle by rotating map.

Finding An Azimuth With Compass

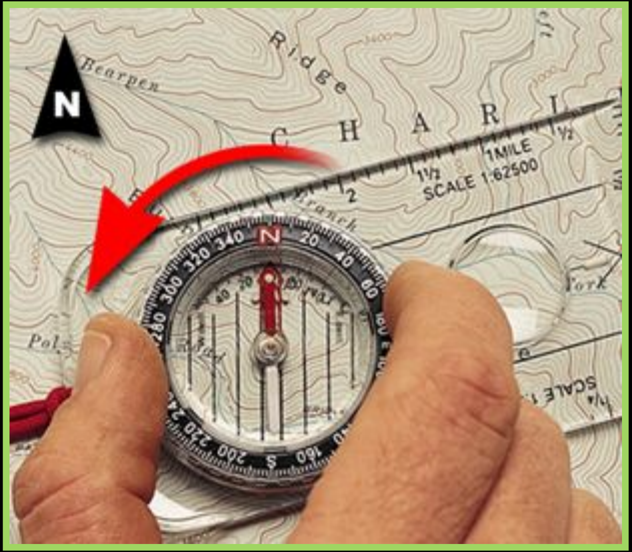
(With Map Oriented To North)

Traveling To a Target On The Map – Step 1



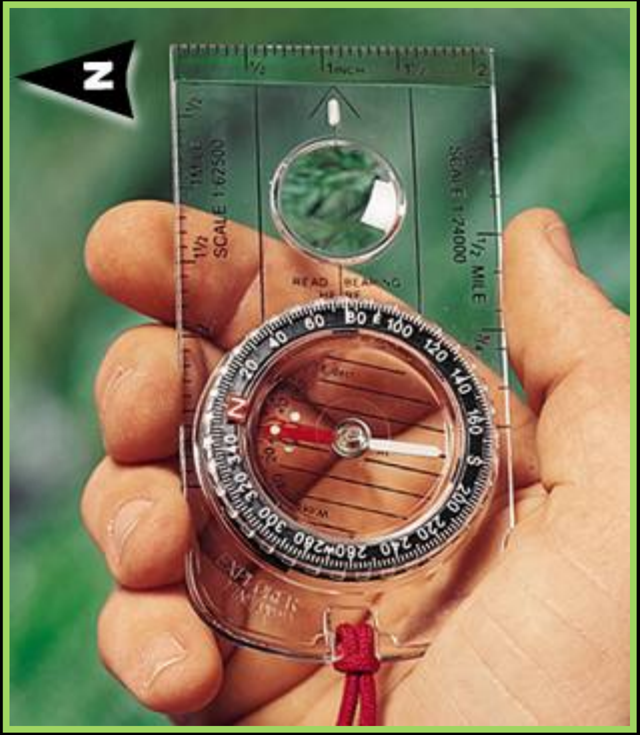
1) **Draw a line on the map from your starting point to your finish point.**
2) **Orient the map to north.**
3) **Place the compass on the map with the edge of the compass on the line and the bearing arrow pointing at your destination**

Traveling To a Target On The Map – Step 2


N
Bearpen
Ridge
C H A R L
1 MILE
1½
SCALE 1:62500
Branch
N
20
40
60
340
320
300
280
Fork
Pol
SCALE

Set Compass Heading - Turn the dial on the compass until "N" outline arrow boxes the compass needle. Your direction to your target (in degrees) is read at the Index Line on the Dial.

Traveling To a Target On The Map – Step 3

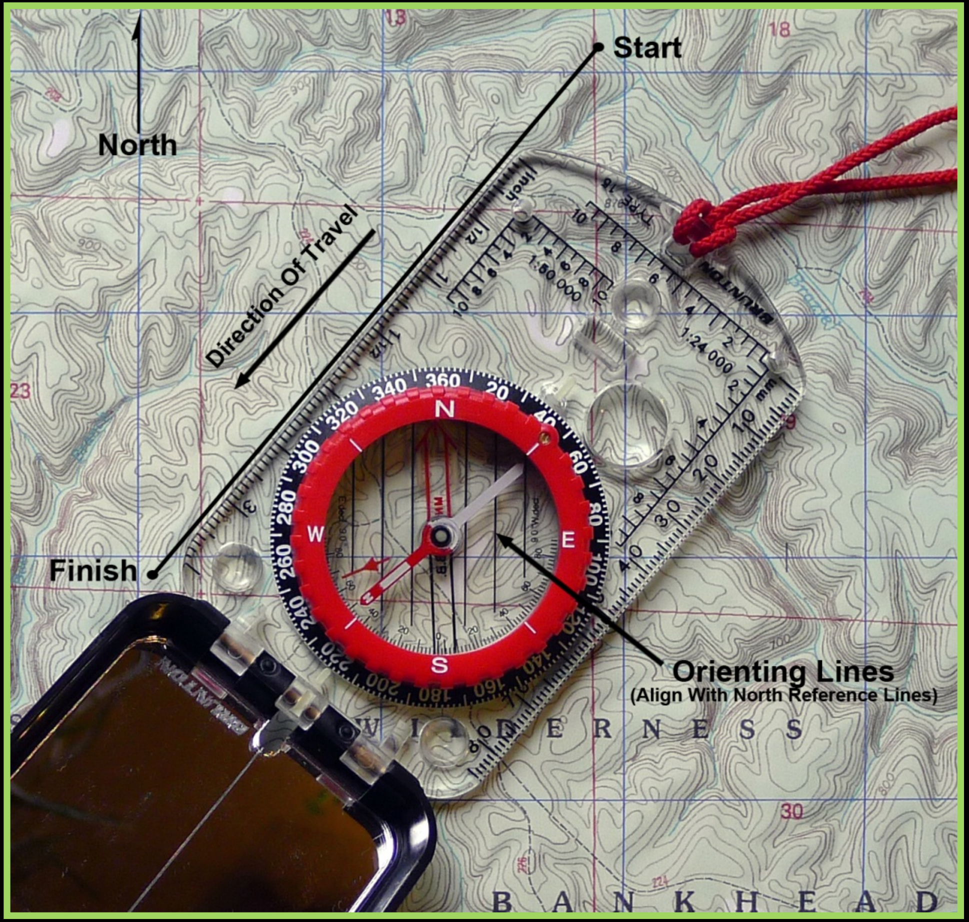


Follow Your Heading - Remove the compass from the map and hold it level, so the Magnetic Needle is free to turn. Turn your body until the red end of the Needle aligns with the Orienting Arrow (boxed) and "N" on the Dial. Using the Direction of Travel Arrow, sight a distant landmark and move to it. Repeat this process until you reach your destination.

Finding An Azimuth With Compass

(Without Map Oriented To North)

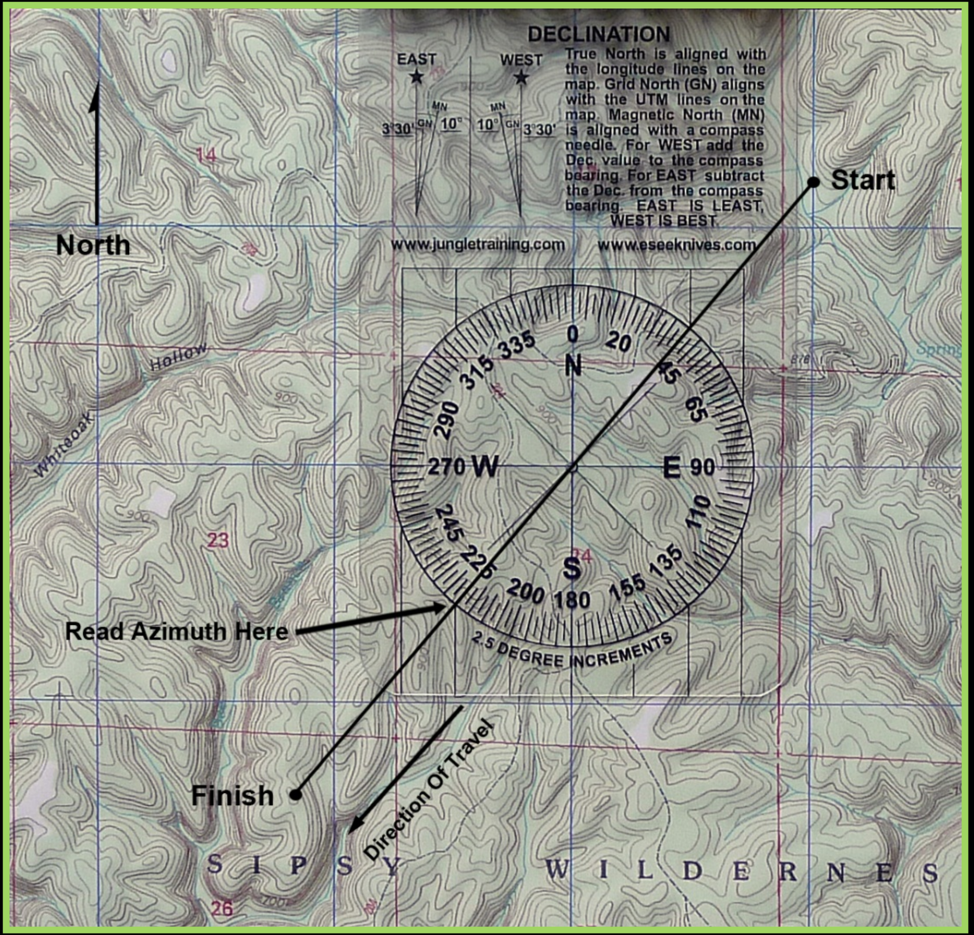
- Draw a line from start to finish.
- Lay the edge of your compass on the line in the direction you are traveling.
- Rotate the compass bezel until the orienting lines align with your North Reference Lines (Make sure that North is pointing to North on the map).
- Pick up your compass and travel to the destination.
- Note: The compass shown has already been adjusted for declination.


Start
North
Direction Of Travel
Finish
Orienting Lines
(Align With North Reference Lines)

Finding An Azimuth With Compass Card

(Without Map Oriented To North)

- Draw a line from start to finish.
- Lay the compass rose on the line so the line crosses through the center of the rose.
- Align N / S line or orienting lines on the compass rose with North Reference Line.
- Read your azimuth on the "Finish" side of the compass rose.
- Note: unless you are using a compass adjusted for declination, you will have to add or subtract the declination value to the value that you acquire from the compass rose.

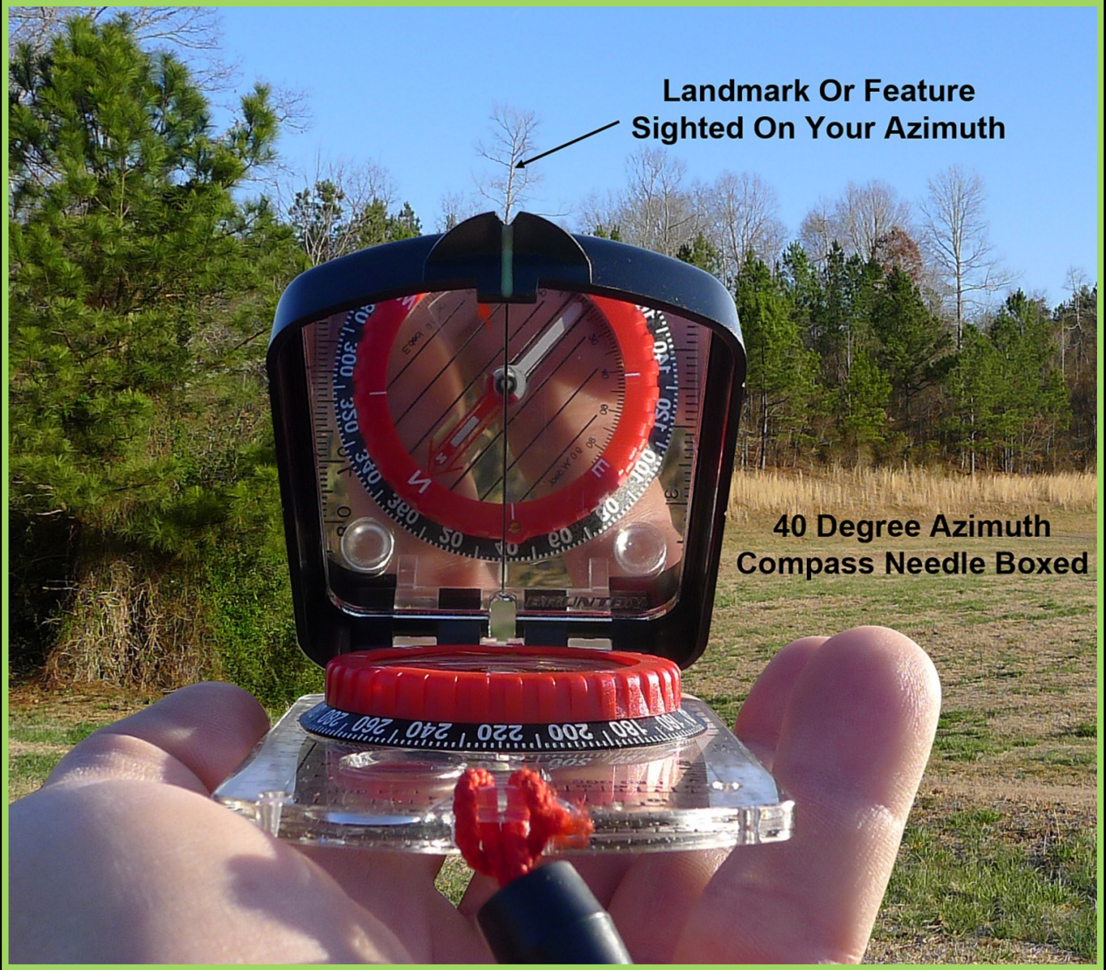


DECLINATION

True North is aligned with the longitude lines on the map. Grid North (GN) aligns with the UTM lines on the map. Magnetic North (MN) is aligned with a compass needle. For WEST add the Dec. value to the compass bearing. For EAST subtract the Dec. from the compass bearing. EAST IS LEAST, WEST IS BEST.

EAST
WEST
MN
GN
3°30'
10°
www.jungletraining.com
www.eseeknives.com
North
Start
Finish
Read Azimuth Here
Direction Of Travel
0
N
20
45
65
E 90
110
135
155
180
S
200
225
245
270 W
290
315
335
2.5 DEGREE INCREMENTS
Hollow
Whiteoak
14
23
24
26
SIPSY WILDERNESS

Traveling To a Target With Sighting Compass



Landmark Or Feature Sighted On Your Azimuth

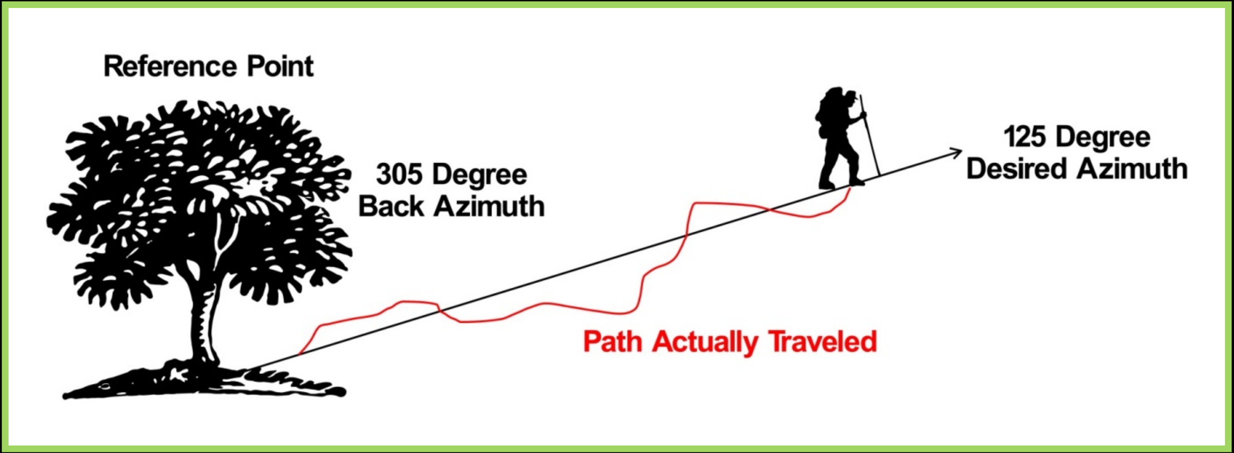
40 Degree Azimuth Compass Needle Boxed

Posting Up

In addition to using natural landmarks as targets for your direction of travel, you can also post up a member of your team as a target. Another option is the Back Azimuth.

Ft. Payne, AL
3.5 Degrees West

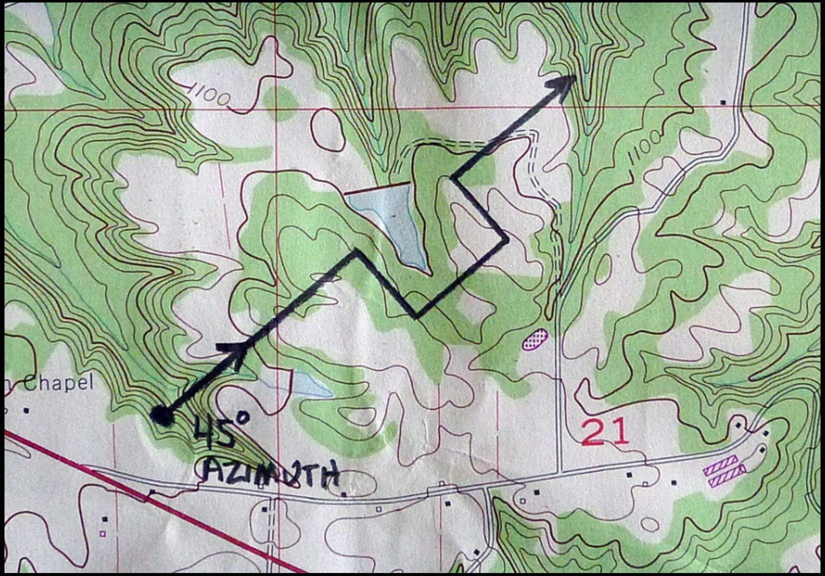
Back Azimuth


Reference Point
305 Degree
Back Azimuth
125 Degree
Desired Azimuth
Path Actually Traveled

Use a Back Azimuth if you need to verify you are still on your desired direction of travel. This is especially handy when crossing rivers or boxing around objects.

Back Azimuth is 180 degrees from your target azimuth. If your target azimuth is more than 180 degrees, then subtract 180. If it is less than 180, then add 180.

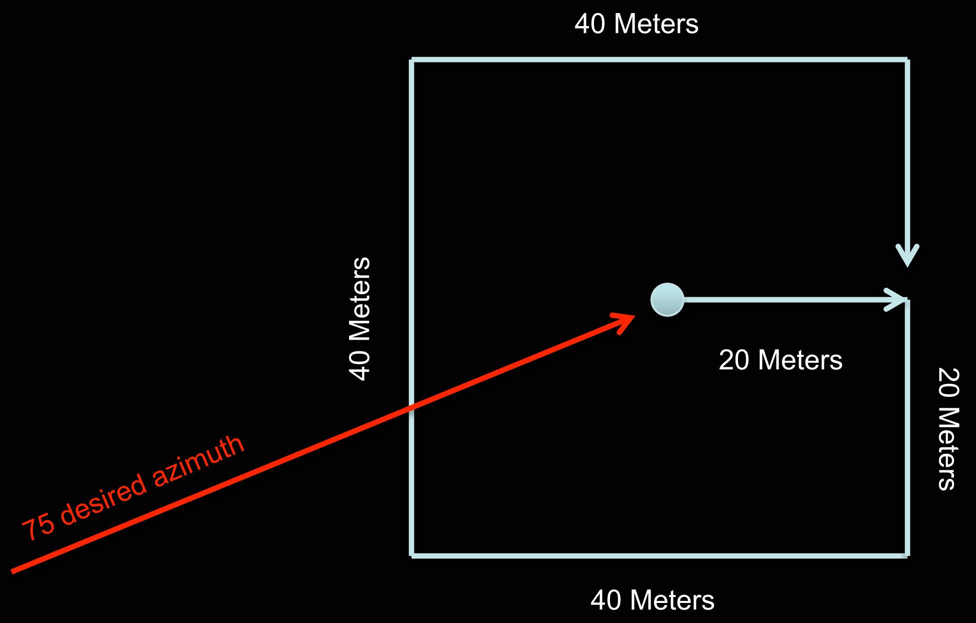
Boxing Around Objects



- Direction of original travel is 45 degrees
- Turn 90 degrees to a new azimuth of 135 (count your paces)
- Turn 90 degrees back to the original azimuth of 45 degrees until you are past obstacle
- Turn 90 degrees to a new azimuth of 315 and pace the same amount as the first turn
- Turn 90 degrees back to the original azimuth of 45 degrees and continue on

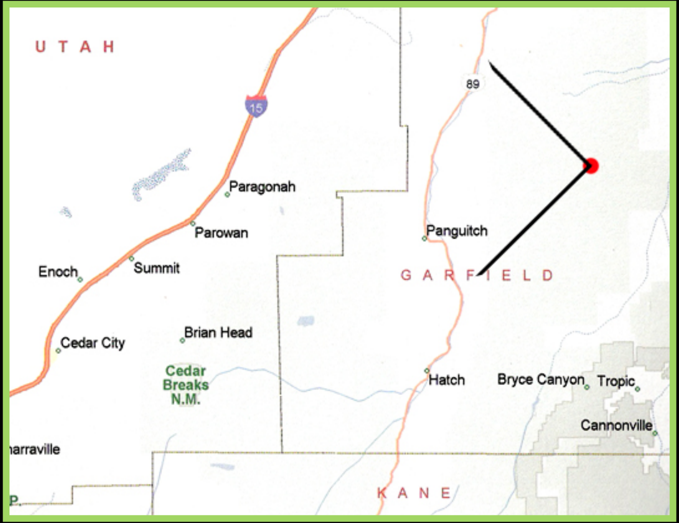
LATERAL DRIFT – MISSING YOUR TARGET

If you cannot find your target after walking your azimuth the correct distance, then mark the spot where you think it should be and began a structured grid search of the area. Make note of your azimuths, pace count and direction changes. Start your grid small then go larger if you cannot locate the target.


40 Meters
40 Meters
20 Meters
20 Meters
75 desired azimuth
40 Meters

Ft. Payne, AL
3.5 Degrees West

Gross Direction Navigation

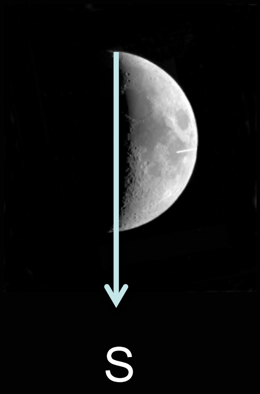

UTAH
15
89
Paragonah
Parowan
Panguitch
Enoch
Summit
GARFIELD
Brian Head
Cedar City
Cedar Breaks N.M.
Hatch
Bryce Canyon
Tropic
Cannonville
arraville
P.
KANE

As obvious from this simple road map, the lost hiker only needs to travel a westerly direction to cross a road and reach civilization. Always know which general direction crosses a main artery!

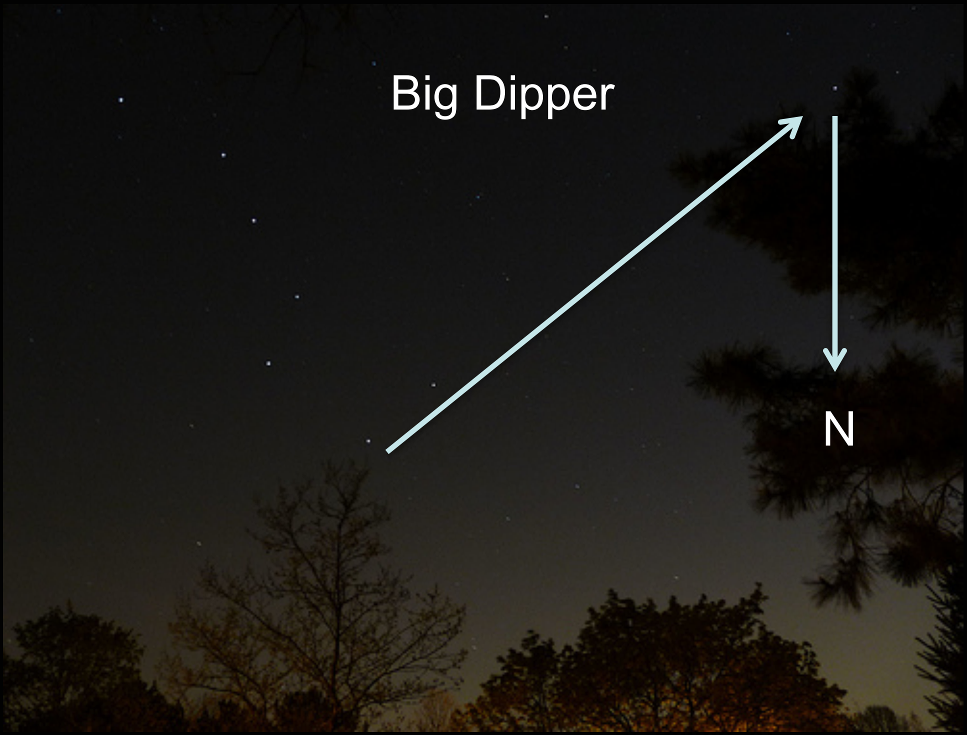
3.5 Degrees West

When using a map and compass always have a “panic azimuth.”

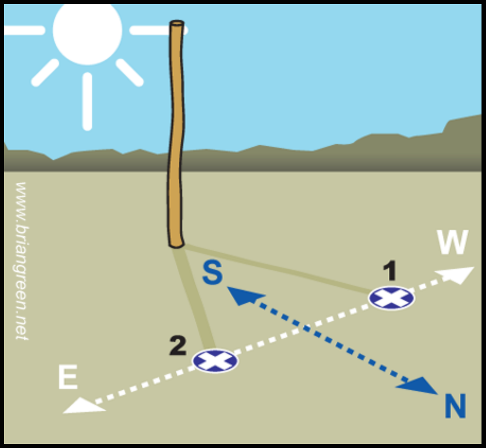
Gross Direction Navigation Aids



Quarter Moon



Big Dipper


www.briangreen.net
S
1
W
2
E
N

Shadow Stick

Terrain Association Navigation

This is the most widely used method of navigation. The navigator plans his route so that he moves from terrain feature to terrain feature. An automobile driver in a city uses this technique as he moves along a street or series of streets, guiding on intersections or features such as stores, parks or houses. Like the driver, the navigator selects routes or *streets* between key points or *intersections*. These key points can be lakes, mountains, roads or any other terrain feature readily recognized on a map. Before you hike a new area, familiarize yourself with the terrain by studying maps, satellite photos or any other available information.

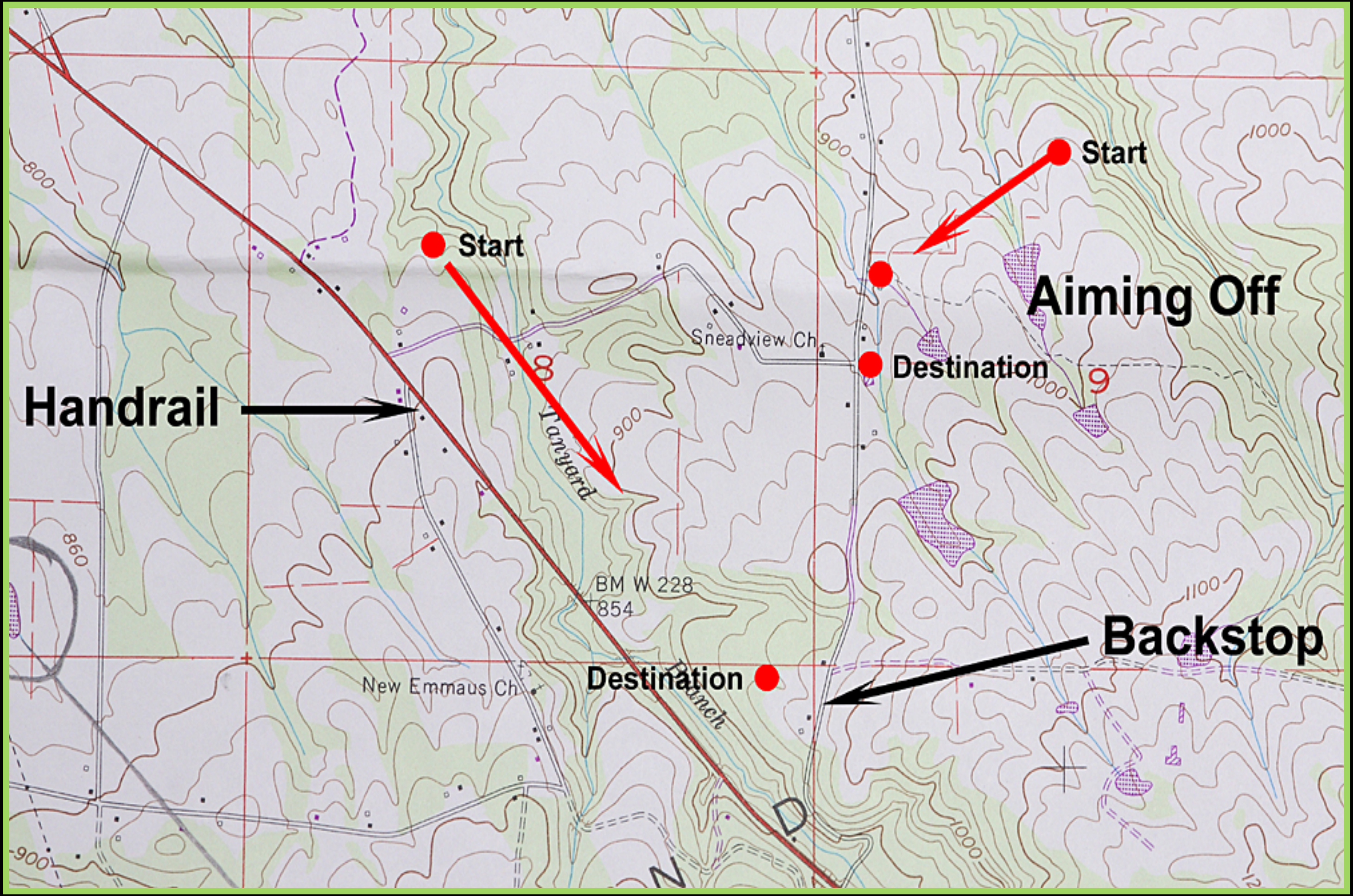
Backstops, Handrails & Aiming Off

BACKSTOPS are features that typically run perpendicular to your azimuth and located beyond your target point. If you run into your backstop then you know you have traveled too far and missed your target point. Backstops can be rivers, roads, mountains, railroad tracks or any other useable feature.

HANDRAILS are features that run parallel to your azimuth. They can be rivers, roads, mountains, or any other useable feature that the navigator can use to continue traveling in the desired direction.

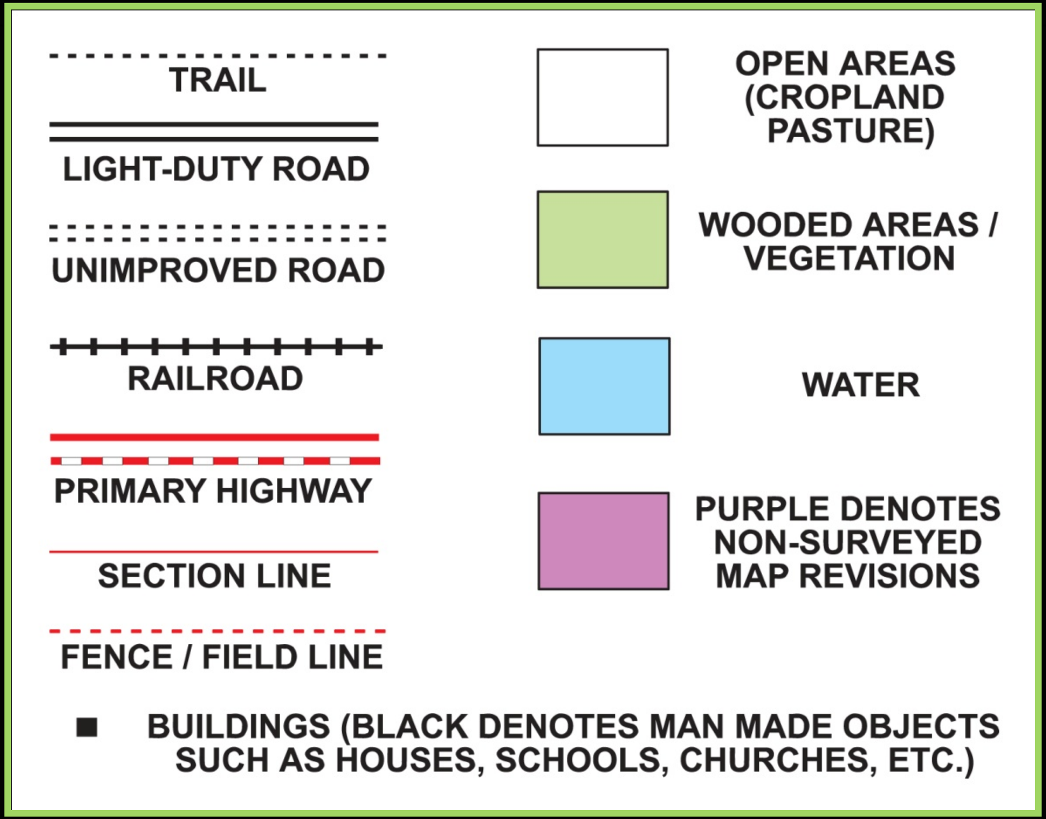
AIMING OFF is a process of deliberately adding or subtracting to the desired azimuth so the navigator knows which way to go once they reach a feature (such as a trail or road) that leads to the target.

Backstops, Handrails & Aiming Off


Start
Start
Aiming Off
Destination
Destination
Handrail
Backstop
Sneadview Ch
New Emmaus Ch
BM W 228
854
Tanyard
Branch
800
900
1000
1100
860

TOPO MAP BASICS

BASICS SYMBOLS



TRAIL

LIGHT-DUTY ROAD

UNIMPROVED ROAD

RAILROAD

PRIMARY HIGHWAY

SECTION LINE

FENCE / FIELD LINE

OPEN AREAS (CROPLAND PASTURE)

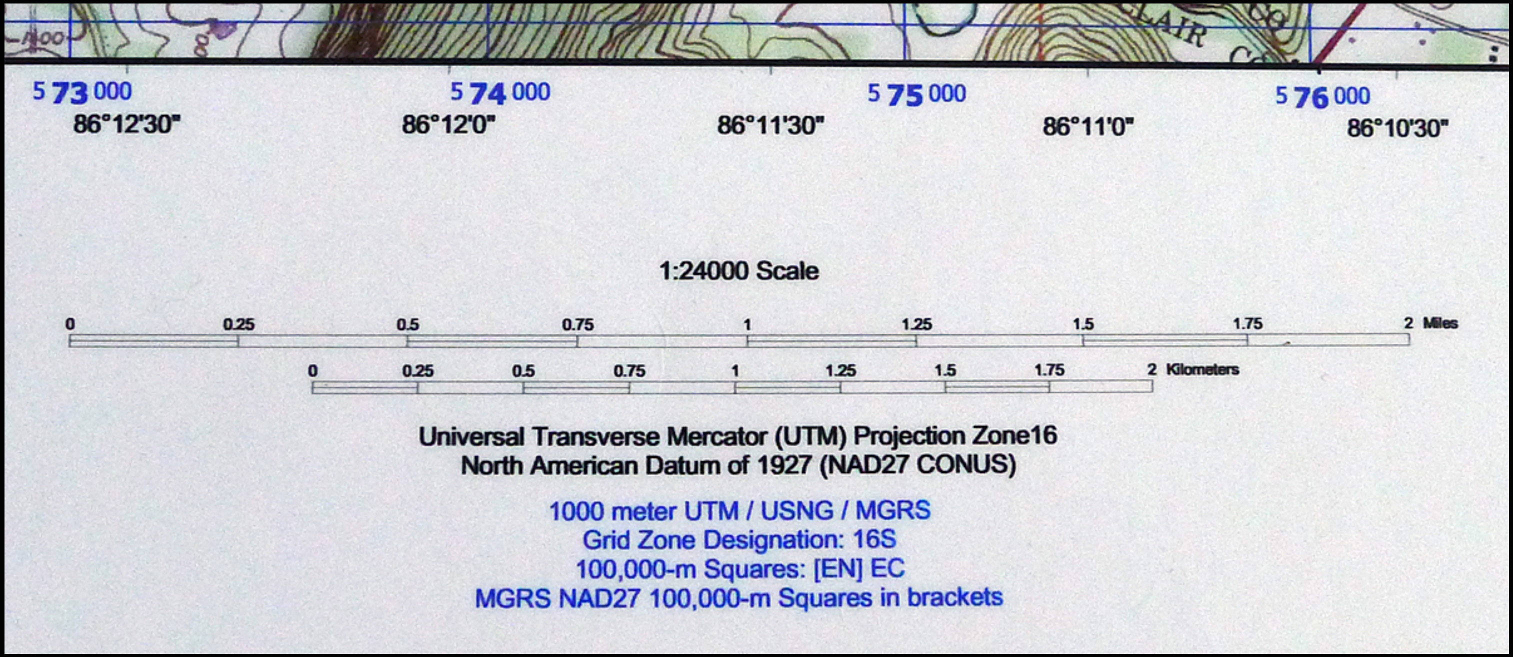
WOODED AREAS / VEGETATION

WATER

PURPLE DENOTES NON-SURVEYED MAP REVISIONS

■ BUILDINGS (BLACK DENOTES MAN MADE OBJECTS SUCH AS HOUSES, SCHOOLS, CHURCHES, ETC.)

Map Scale & Datum



5 73 000
86°12'30"
5 74 000
86°12'0"
86°11'30"
5 75 000
86°11'0"
5 76 000
86°10'30"

1:24000 Scale

0
0.25
0.5
0.75
1
1.25
1.5
1.75
2 Miles
0
0.25
0.5
0.75
1
1.25
1.5
1.75
2 Kilometers

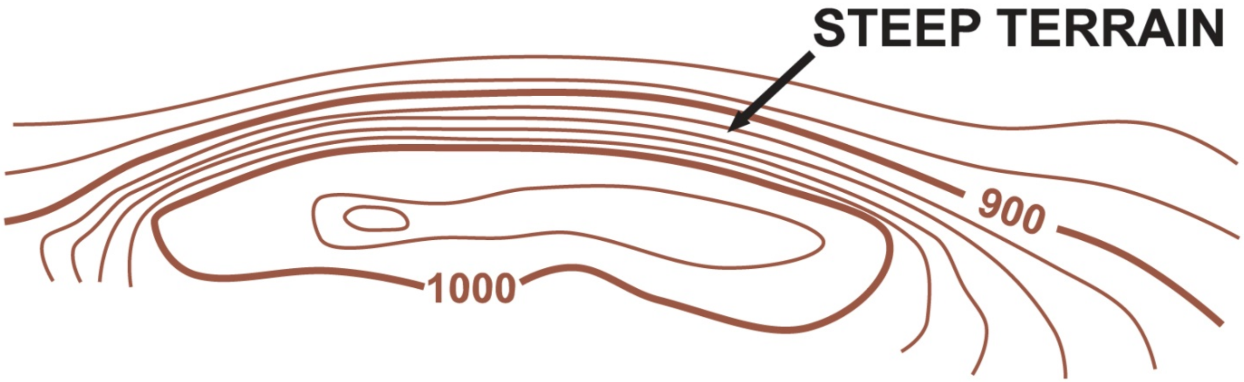
Universal Transverse Mercator (UTM) Projection Zone16
North American Datum of 1927 (NAD27 CONUS)

1000 meter UTM / USNG / MGRS
Grid Zone Designation: 16S
100,000-m Squares: [EN] EC
MGRS NAD27 100,000-m Squares in brackets

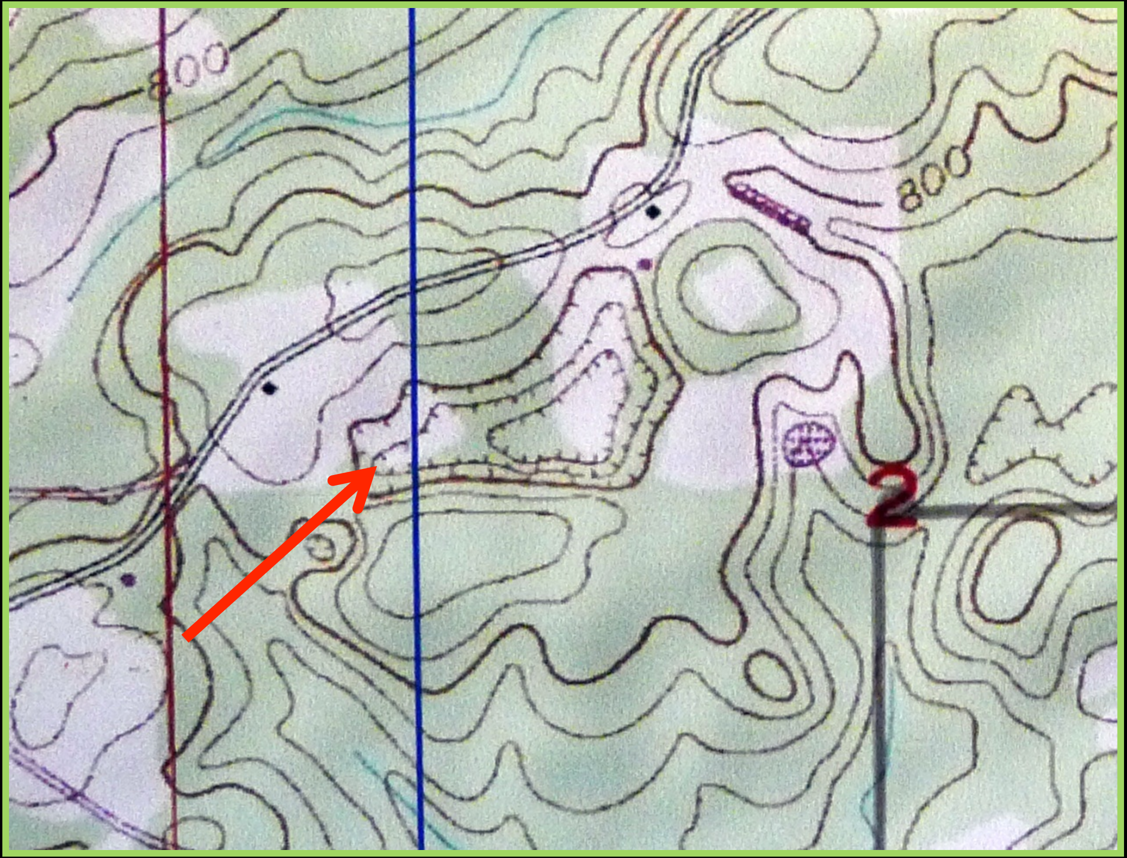
Always set your GPS to the map datum shown on your map!
Always use the proper scale card for measuring!

CONTOUR LINES

The closer the contour lines, the steeper the terrain. Check the map for the contour intervals. Contour lines will also have elevation markings.



Example above shows a map with contour intervals of 20 feet.



Depression

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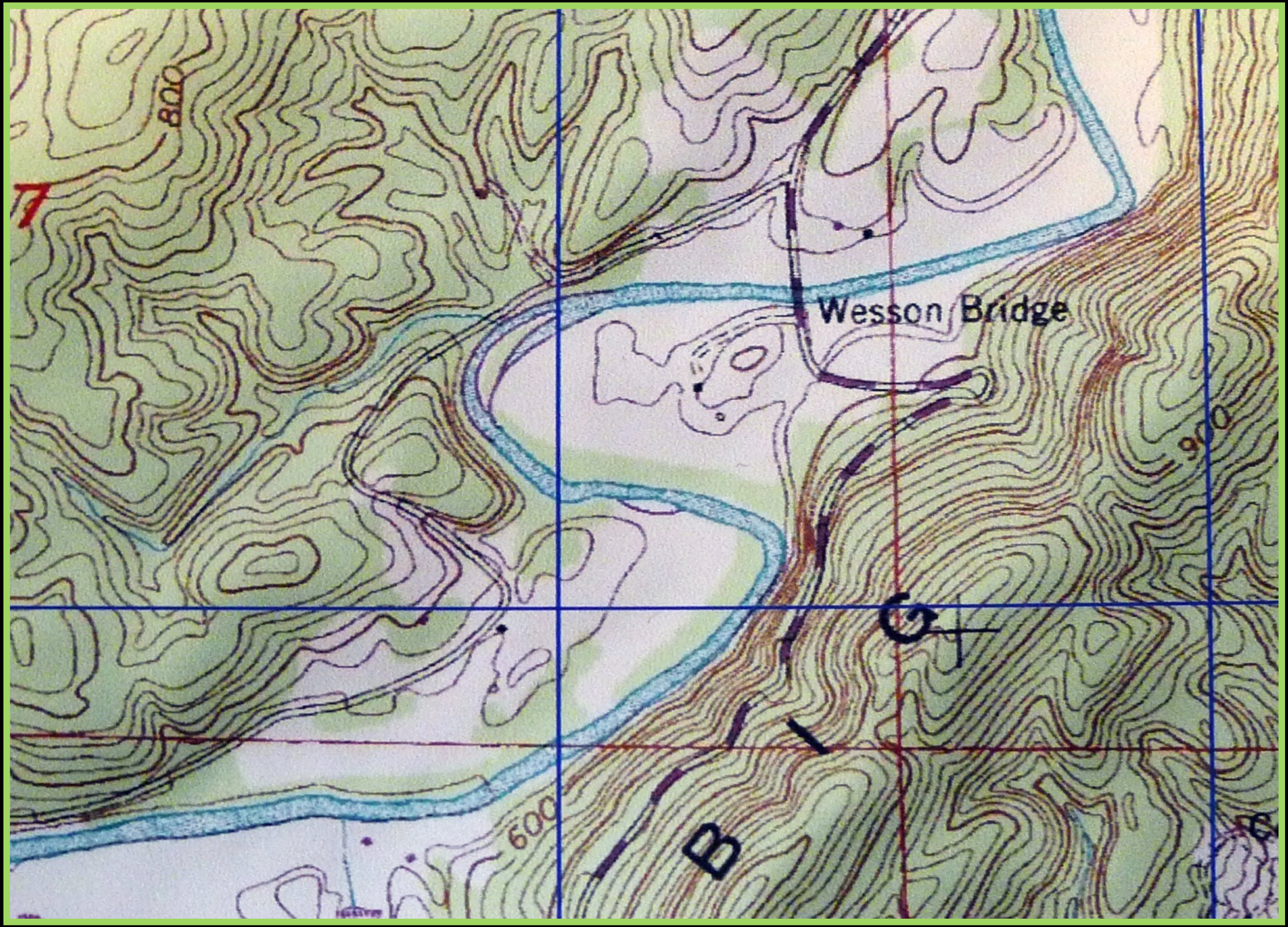
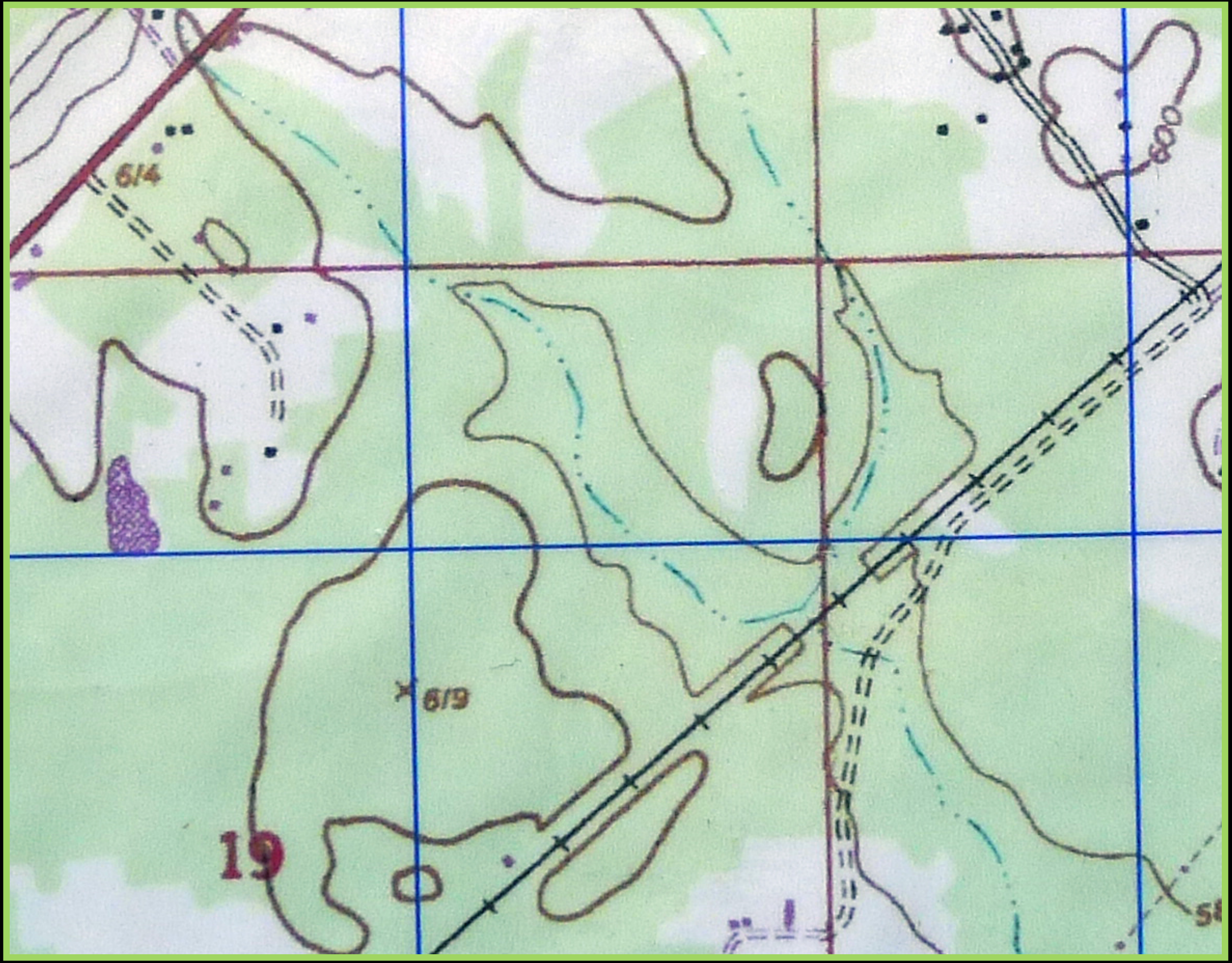
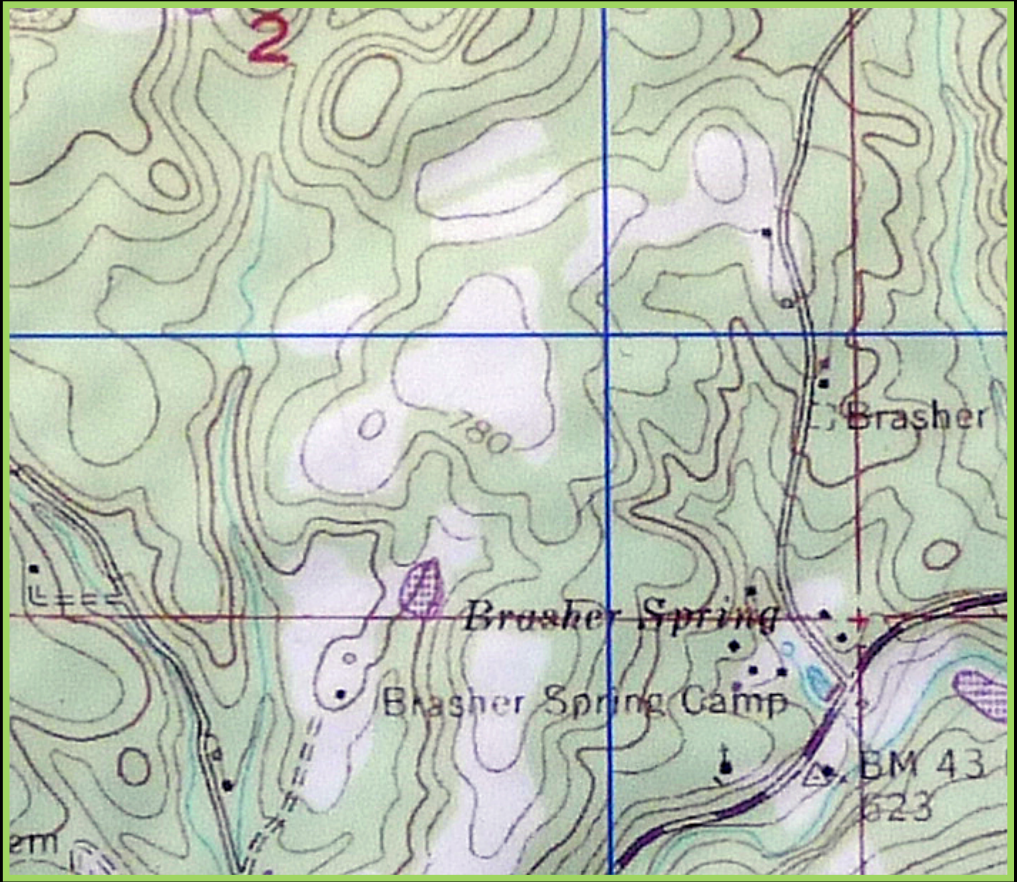

800
Wesson Bridge
900
600
G
B
C

Continuous Water Flow



Intermittent Water Flow


2
780
Brasher
Brasher Spring
Brasher Spring Camp
BM 43
623

Clear Areas / Fields

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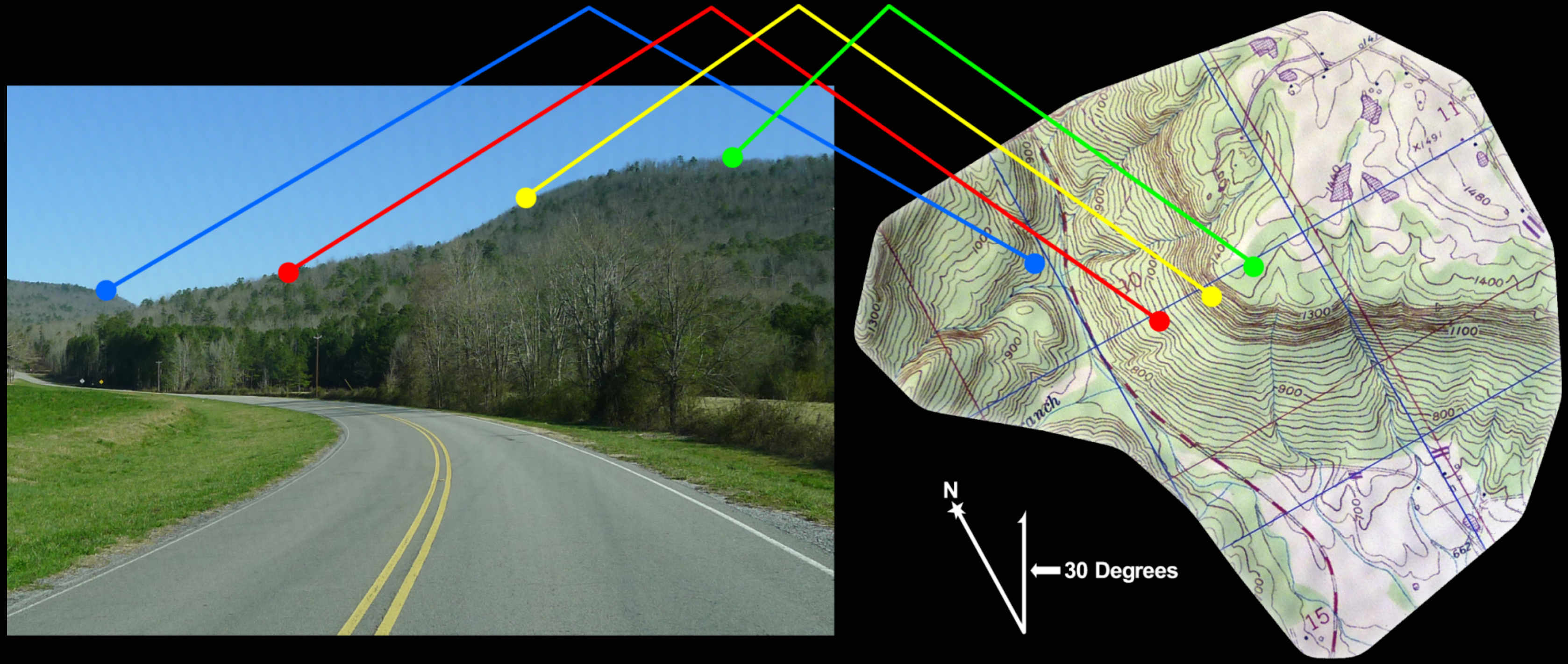
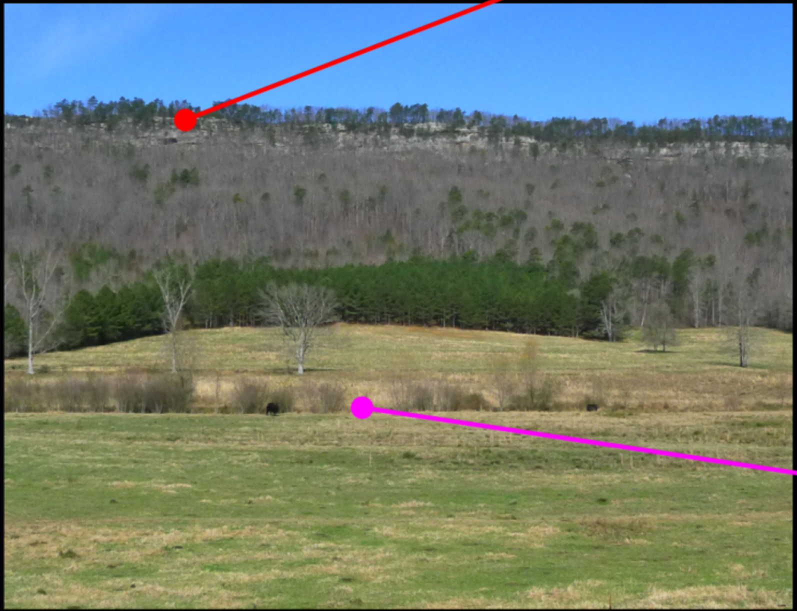
LAND NAVIGATION


N
30 Degrees

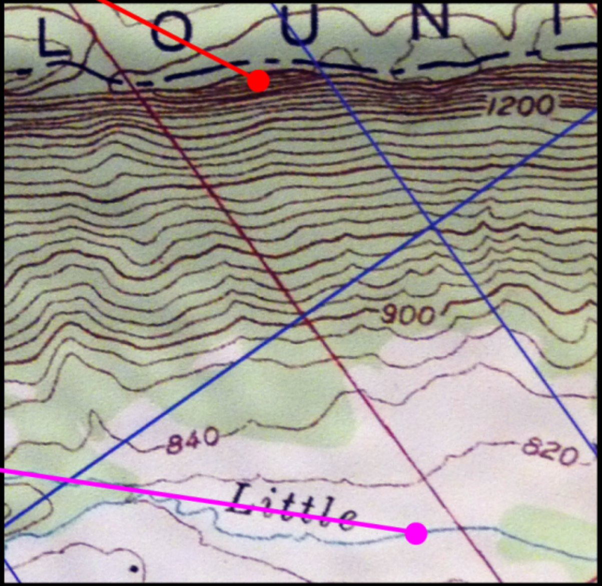
Actual View

Topo View

RANDALL'S ADVENTURE TRAINING ®
LAND NAVIGATION

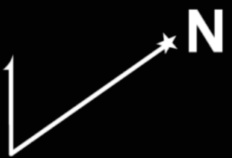


Actual View


L O U N T
1200
900
840
820
Little

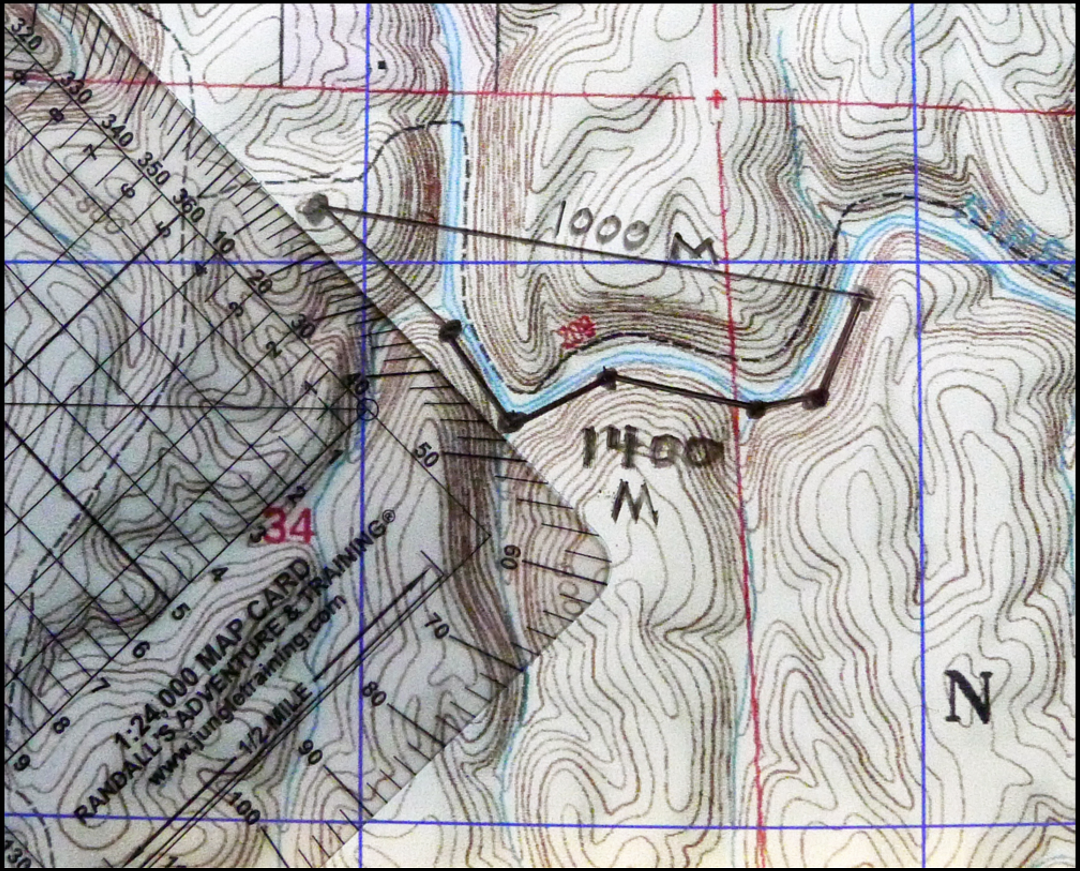
Topo View

300 Degrees ➡



DETERMINING DISTANCE

Determining Distance On Map


1000 M
1400 M
N
34
1:24,000 MAP CARD
RANDALL'S ADVENTURE & TRAINING®
www.jungletraining.com
1/2 MILE
320
330
340
350
360
10
20
30
40
50
60
70
80
90
100

DETERMINE DISTANCE TRAVELED BY PACE COUNT

In thick jungle, where landmarks can not always be seen to track your position, pace counting is the best way of measuring distance. Pace counting will allow the navigator to estimate where he is at any given time. To be accurate, the navigator must practice pacing over different types of terrain. First you have to do some calculations. Measure out exactly 100 meters on three types of ground. Flat easy terrain, rougher terrain with some slope and then steep hill terrain. Then on each measured course count your paces (every time your left foot touches the ground or every 2 steps = 1 pace). You will have 3 different pace counts for different types of terrain. Once finished, memorize your pace count for all 3 types.

Averages

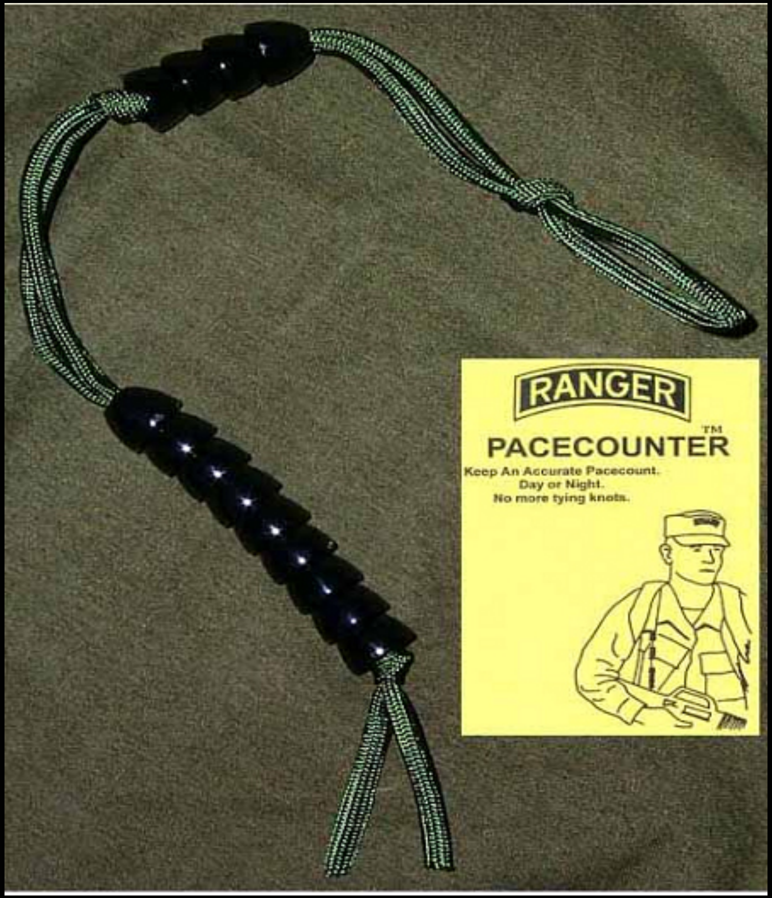
Flat easy terrain	100 meters	65 paces
Rougher terrain with some slope	100 meters	75 paces
Steep hill terrain	100 meters	95 paces

General Rule: You have never traveled as far as you think you have.

CONDITIONS THAT AFFECT PACE COUNT

- Slopes – Your pace lengthens on a downslope and shortens on an upgrade.
- Winds – A headwind shortens the pace and a tailwind increases it.
- Surfaces – Sand, gravel, mud, snow and similar surfaces tend to shorten your pace.
- Elements – Falling rain or snow causes the pace to be reduced in length.
- Clothing – Excess clothing or shoes with poor traction affect the pace length.
- Visibility – Poor visibility due to rain, snow, or fog will shorten your pace.

Ranger Pace Count Beads


RANGER
PACECOUNTER™
Keep An Accurate Pacecount.
Day or Night.
No more tying knots.

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0 meters

100 meters

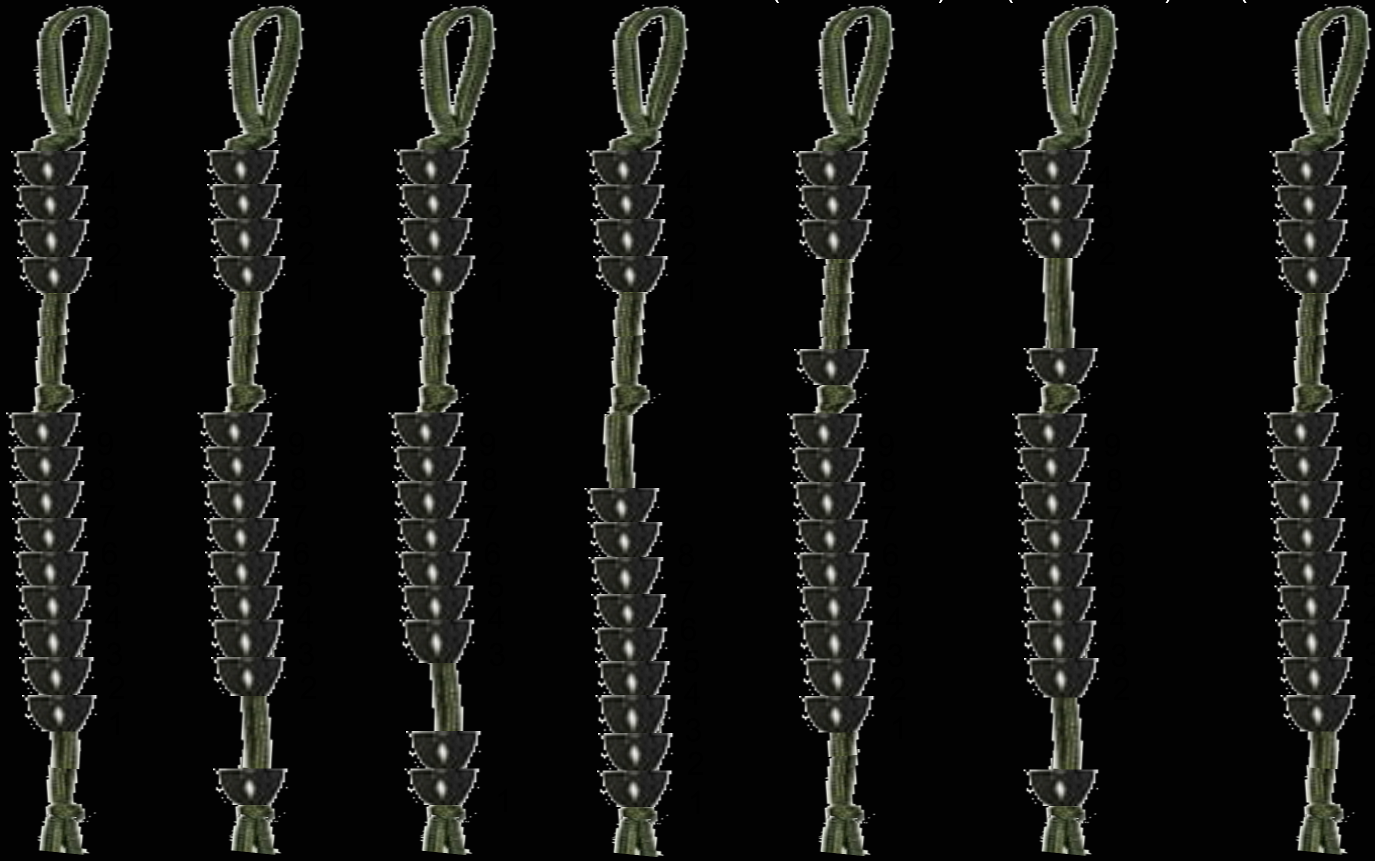
200 meters

900 meters

1000 meters (1 kilometer)

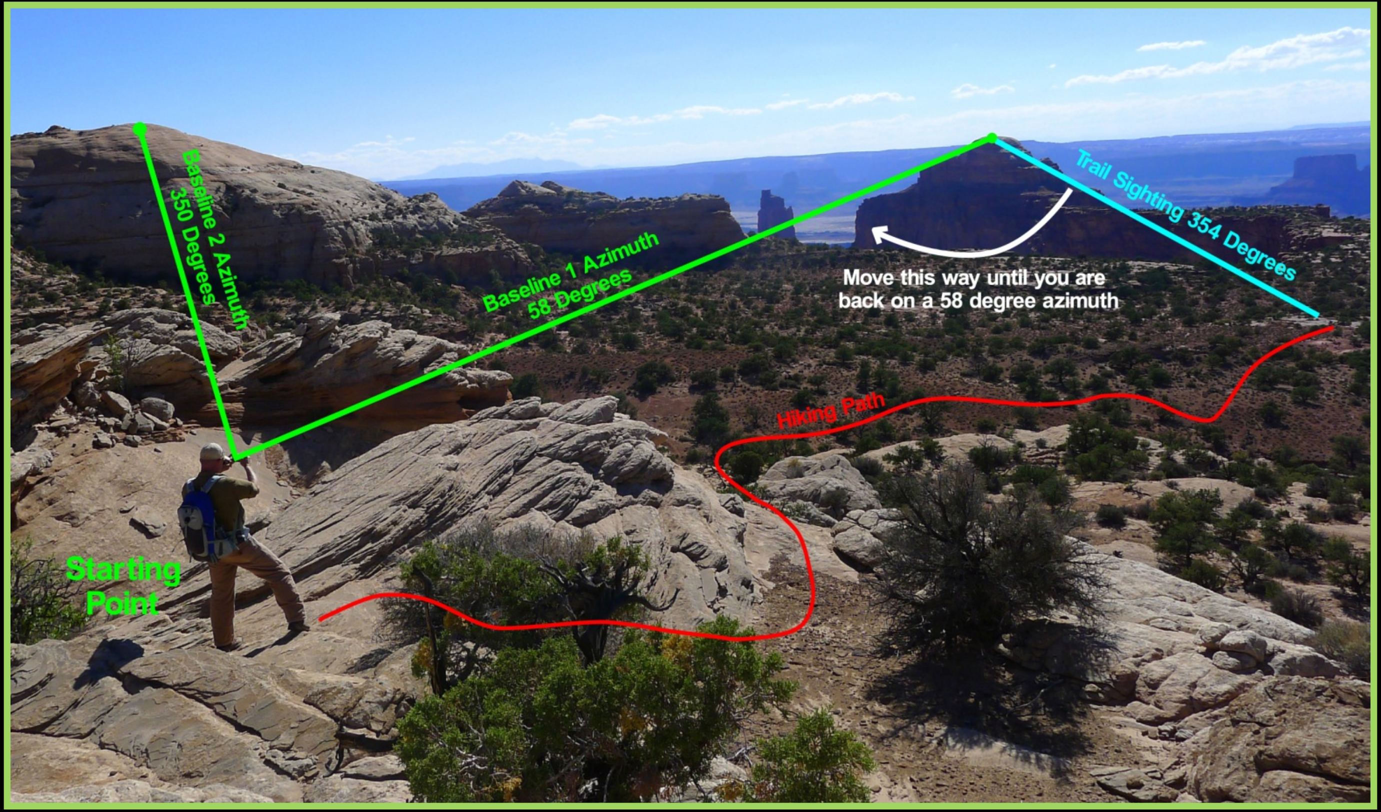
1100 meters (1km 100m)

5000 meters (5 kilometers)



FINDING YOURSELF

Baselines

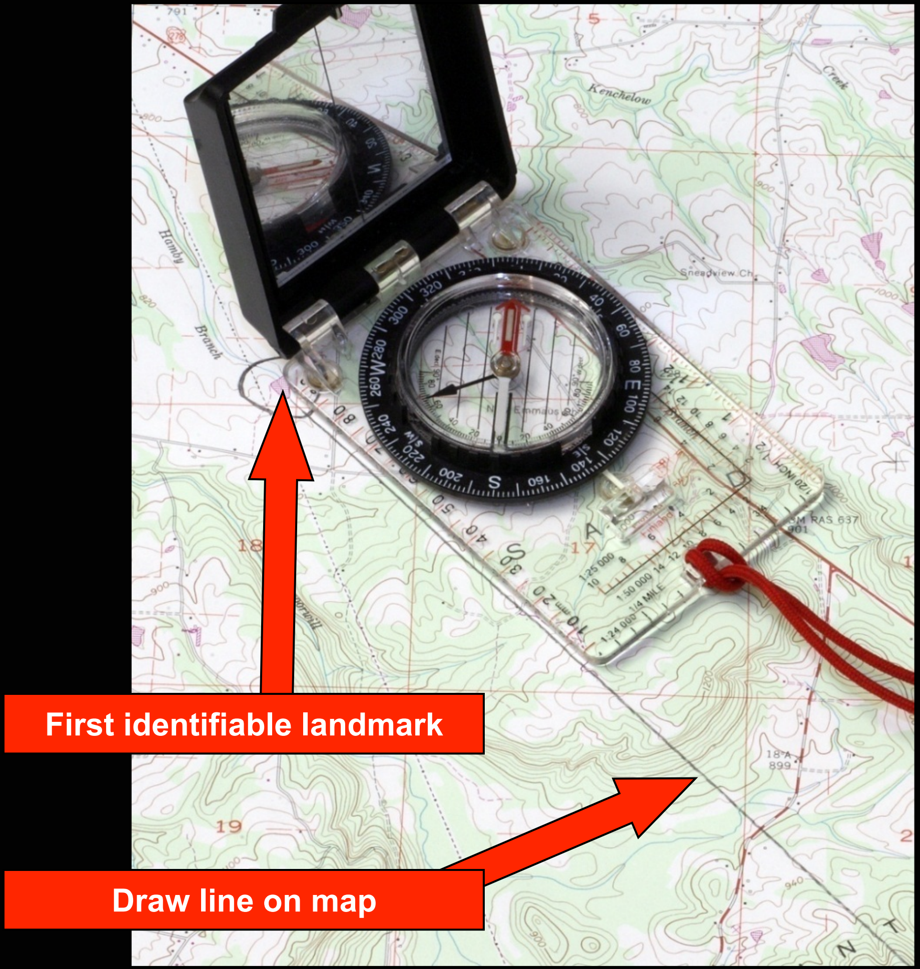

Baseline 2 Azimuth
350 Degrees
Baseline 1 Azimuth
58 Degrees
Trail Sighting 354 Degrees
Hiking Path
Starting Point

Move this way until you are back on a 58 degree azimuth

Find two prominent features. Shoot an azimuth to the first one and write it down. Shoot an azimuth to the second one and write it down. You can now travel freely. If you get lost, shoot an azimuth to the first feature and move until you get back on your first azimuth. Shoot an azimuth to your second feature and move until you get back on your second azimuth. You will be back at your starting point once both azimuths are the same as the ones you wrote down.

RESECTION

- Orient your map and secure its position. Locate a landmark on the map that you can actually see in the landscape. Take a compass bearing to that landmark by sighting and then rotating compass dial until the needle is boxed. Once you have a bearing, do not move the compass dial. Lay the corner of the compass on the map landmark and rotate the whole compass (not the dial) until the needle is boxed. If done properly the corner of the compass will still be over your landmark. Draw a line along the edge of the compass base.

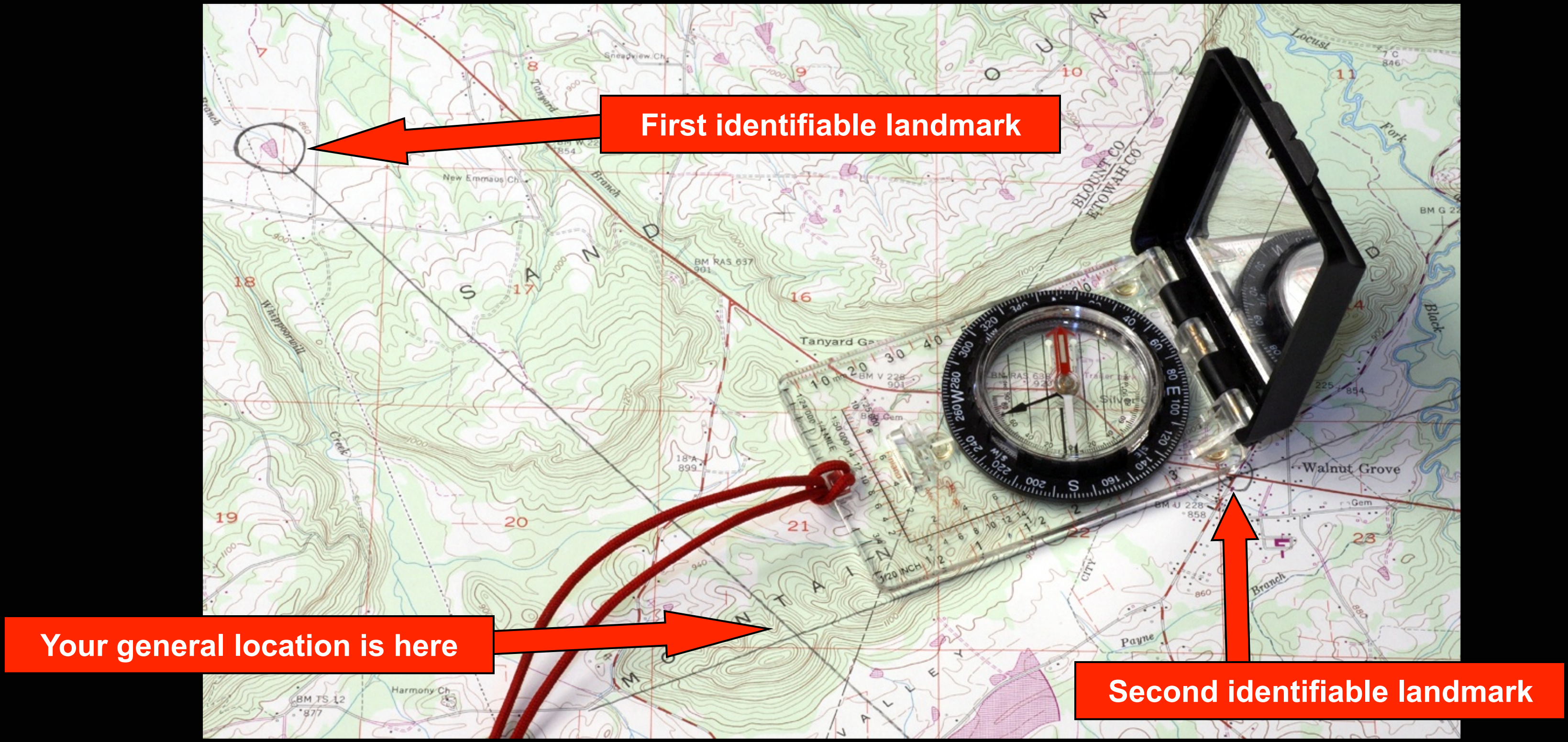


First identifiable landmark

Draw line on map

RESECTION - Step 2

- Find a second identifiable landmark on the map and repeat the process from the previous slide. Where the two lines intersect is roughly where you are on the map.
- Finding a third point on the map and repeating the process is called "triangulation" and increases the accuracy of finding your location.



First identifiable landmark

Your general location is here

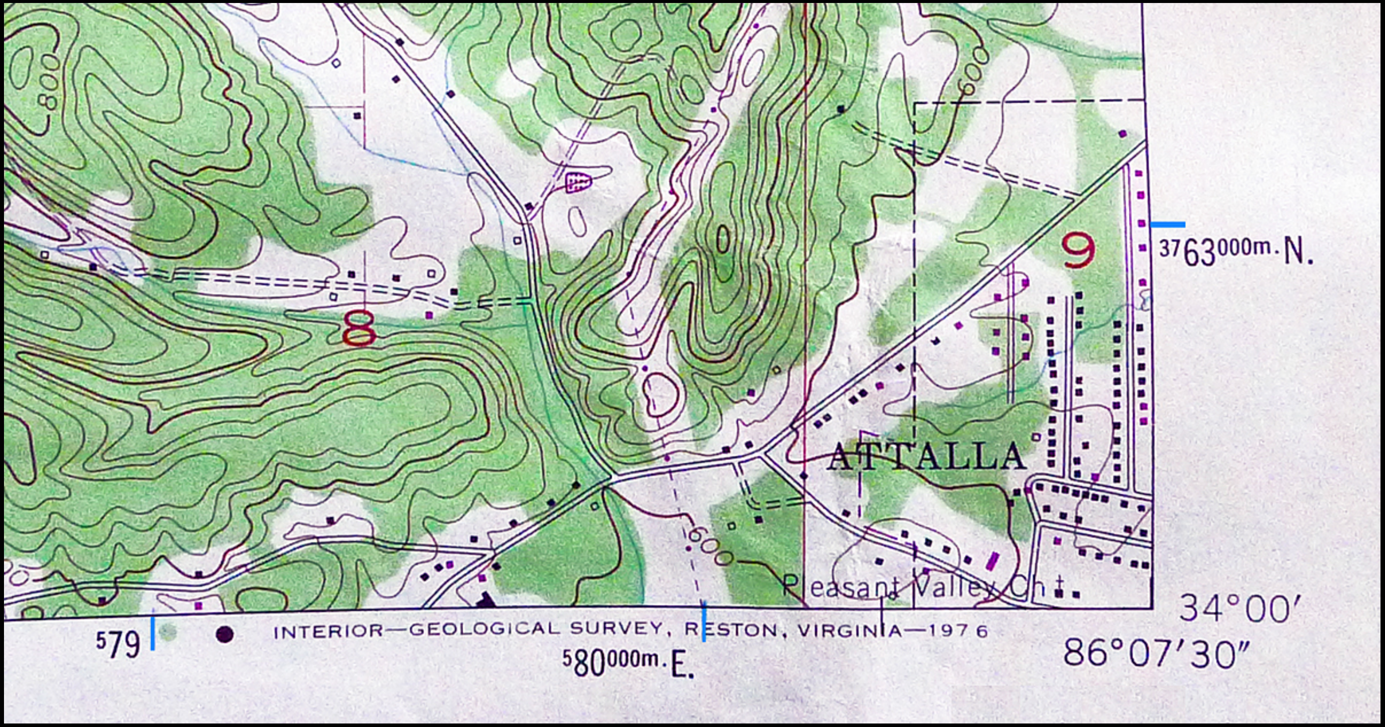
Second identifiable landmark

if you are already on a known location (such as a road, river or mountain ridge) but not sure exactly where you are on this feature, you may only need to shoot one azimuth to determine your exact position on the map

INTERSECTION is the reverse of RESECTION. An example of intersection is seeing smoke from a forest fire and determining where the fire is located on a map.

PLOTTING COORDINATES

Map Grids


8
9
ATTALLA
Pleasant Valley Ch
600
800
3763000m.N.
579
580000m.E.
INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1976
34°00′
86°07′30″

Always set your GPS to the grid system you are using on the map

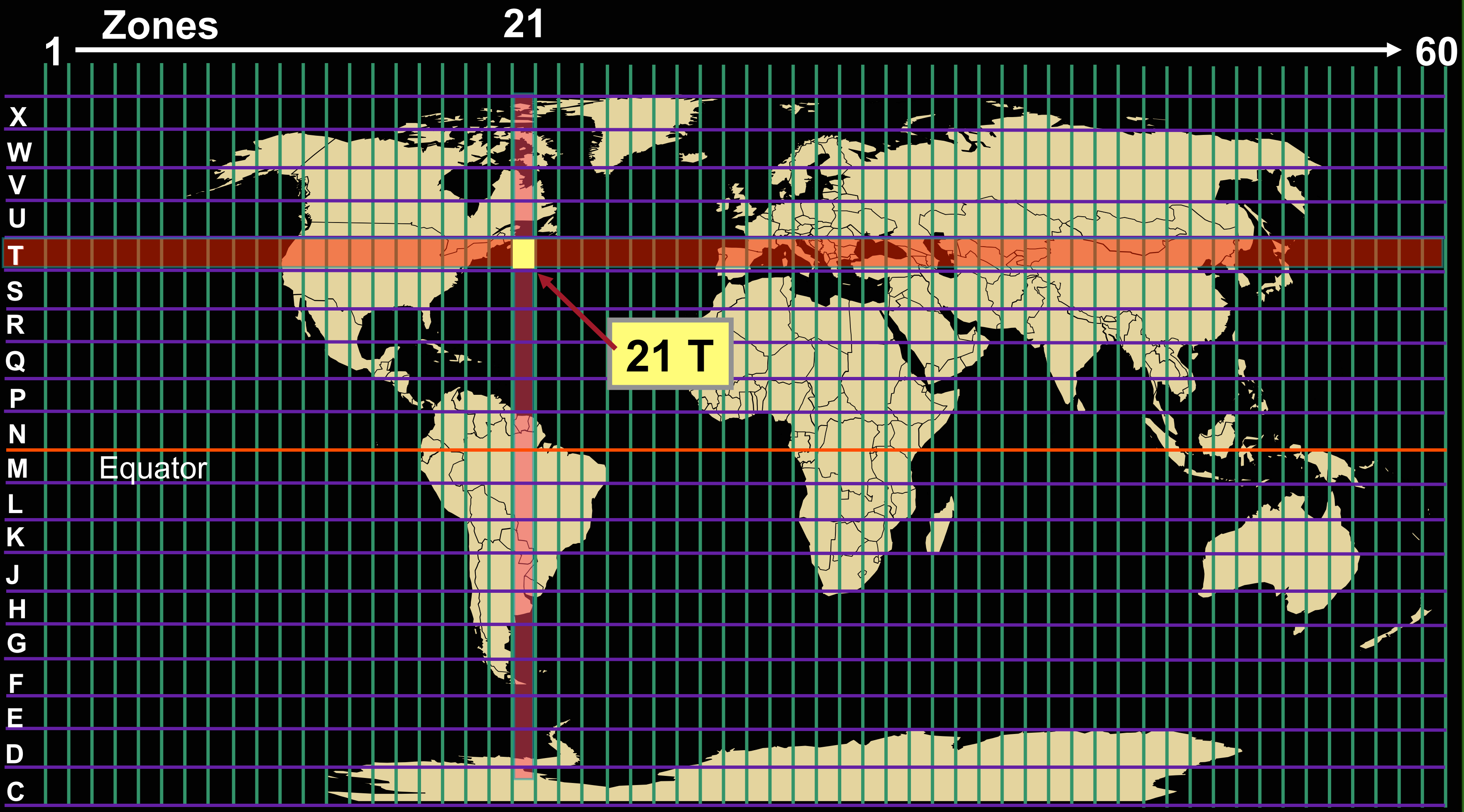
Universal Transverse Mercator (UTM)

UTM is a rectangular coordinate system based on the latitude and longitude (geographic) coordinate system. With UTM, the earth is divided into 60 zones that allows it to be projected onto maps with minimal distortion. All coordinates are expressed in meters.

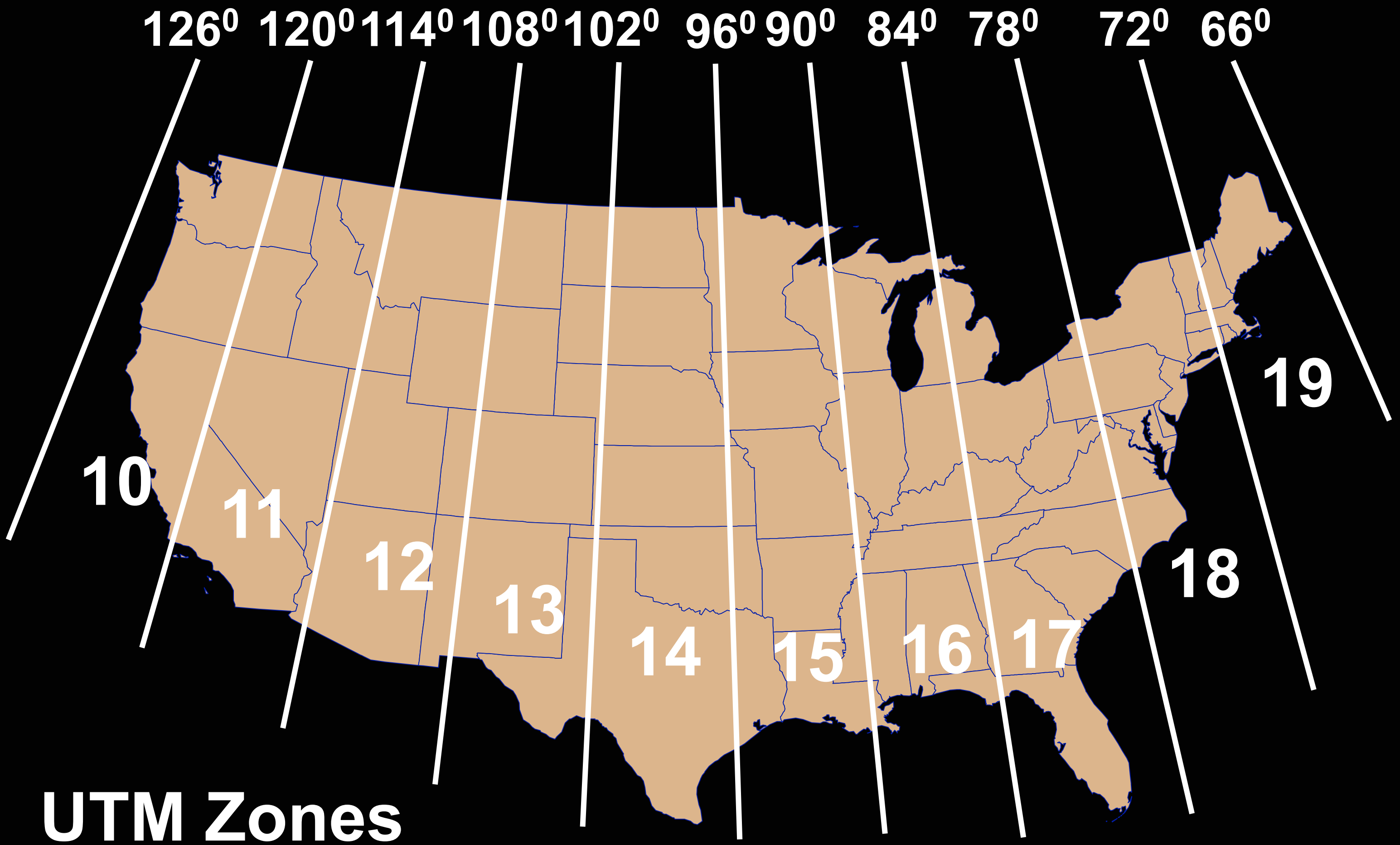
The UTM grid system is the easiest method of relaying your position to others, finding yourself on a map after getting a location fix with a GPS unit, or navigating to a position on a map using a GPS unit.

RANDALL'S ADVENTURE TRAINING ®
LAND NAVIGATION

UTM: 60 Zones and 20 Latitude Bands

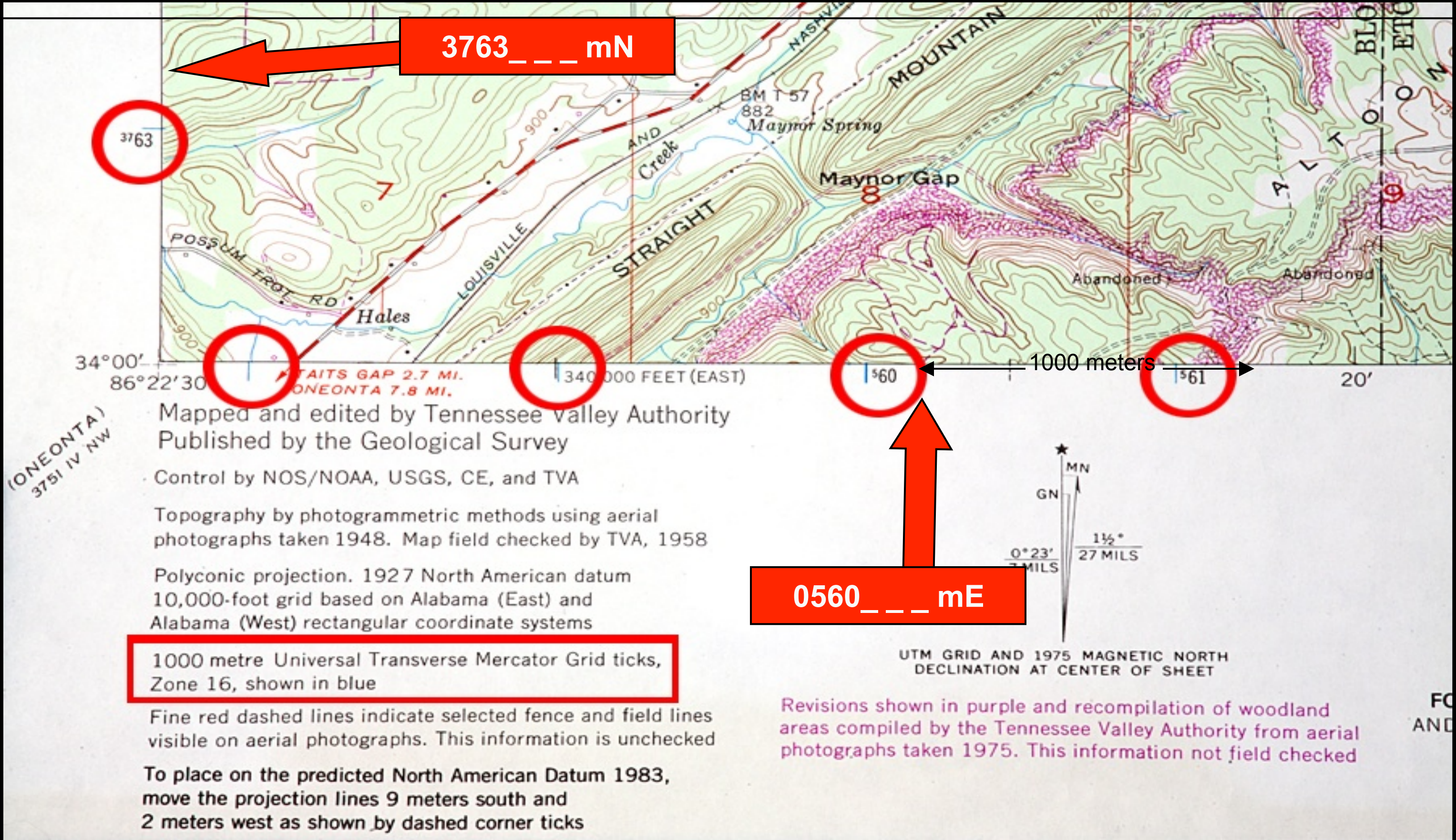

Zones
1
21
60
X
W
V
U
T
S
R
Q
P
N
M
L
K
J
H
G
F
E
D
C
Equator
21 T

RANDALL'S ADVENTURE TRAINING ®
LAND NAVIGATION


126°
120°
114°
108°
102°
96°
90°
84°
78°
72°
66°
10
11
12
13
14
15
16
17
18
19

UTM Zones

Universal Transverse Mercator (UTM)


3763
34°00′
86°22′30″
STRAITS GAP 2.7 MI.
ONEONTA 7.8 MI.
340 000 FEET (EAST)
560
561
20′
POSSUM TROT RD
Hales
LOUISVILLE
STRAIGHT
AND Creek
MOUNTAIN
NASHVILLE
BM T 57
882
Maynor Spring
Maynor Gap
Abandoned
Abandoned
ALTOONA
(ONEONTA 3751 IV NW)
MN
GN
0°23′
7 MILS
1½°
27 MILS
UTM GRID AND 1975 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

3763_ _ _ mN

0560_ _ _ mE

1000 meters

Mapped and edited by Tennessee Valley Authority
Published by the Geological Survey

Control by NOS/NOAA, USGS, CE, and TVA

Topography by photogrammetric methods using aerial photographs taken 1948. Map field checked by TVA, 1958

Polyconic projection. 1927 North American datum
10,000-foot grid based on Alabama (East) and Alabama (West) rectangular coordinate systems

1000 metre Universal Transverse Mercator Grid ticks, Zone 16, shown in blue

Fine red dashed lines indicate selected fence and field lines visible on aerial photographs. This information is unchecked

To place on the predicted North American Datum 1983, move the projection lines 9 meters south and 2 meters west as shown by dashed corner ticks

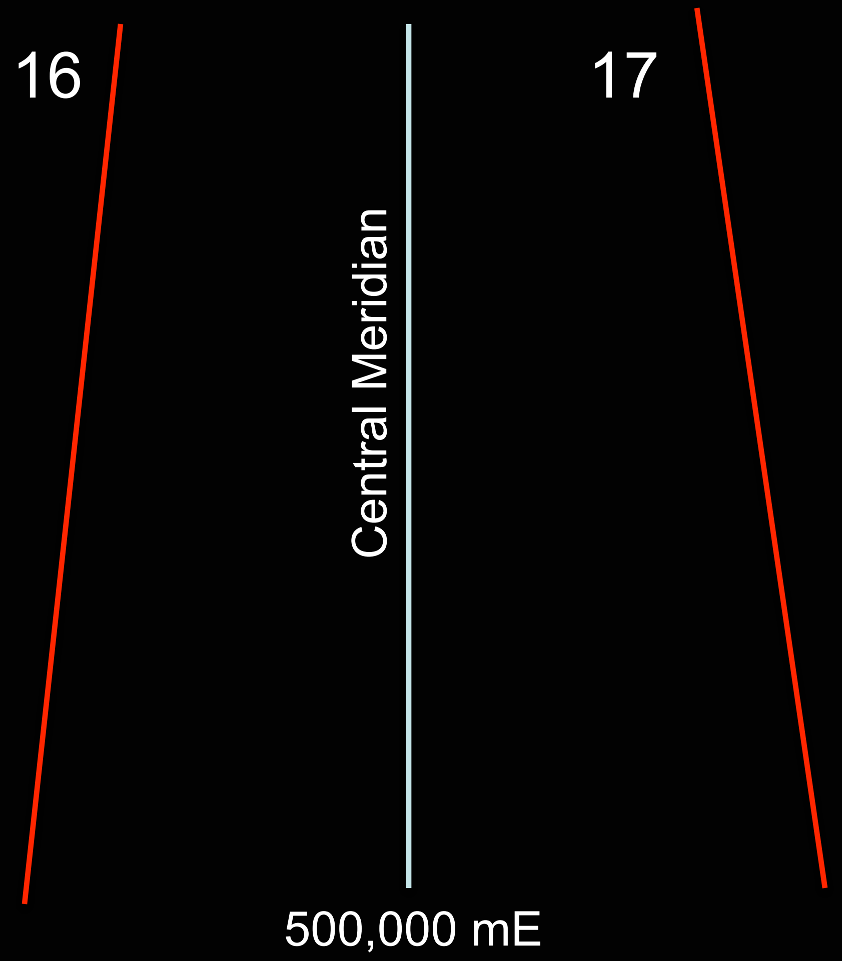
Revisions shown in purple and recompilation of woodland areas compiled by the Tennessee Valley Authority from aerial photographs taken 1975. This information not field checked

Easting:

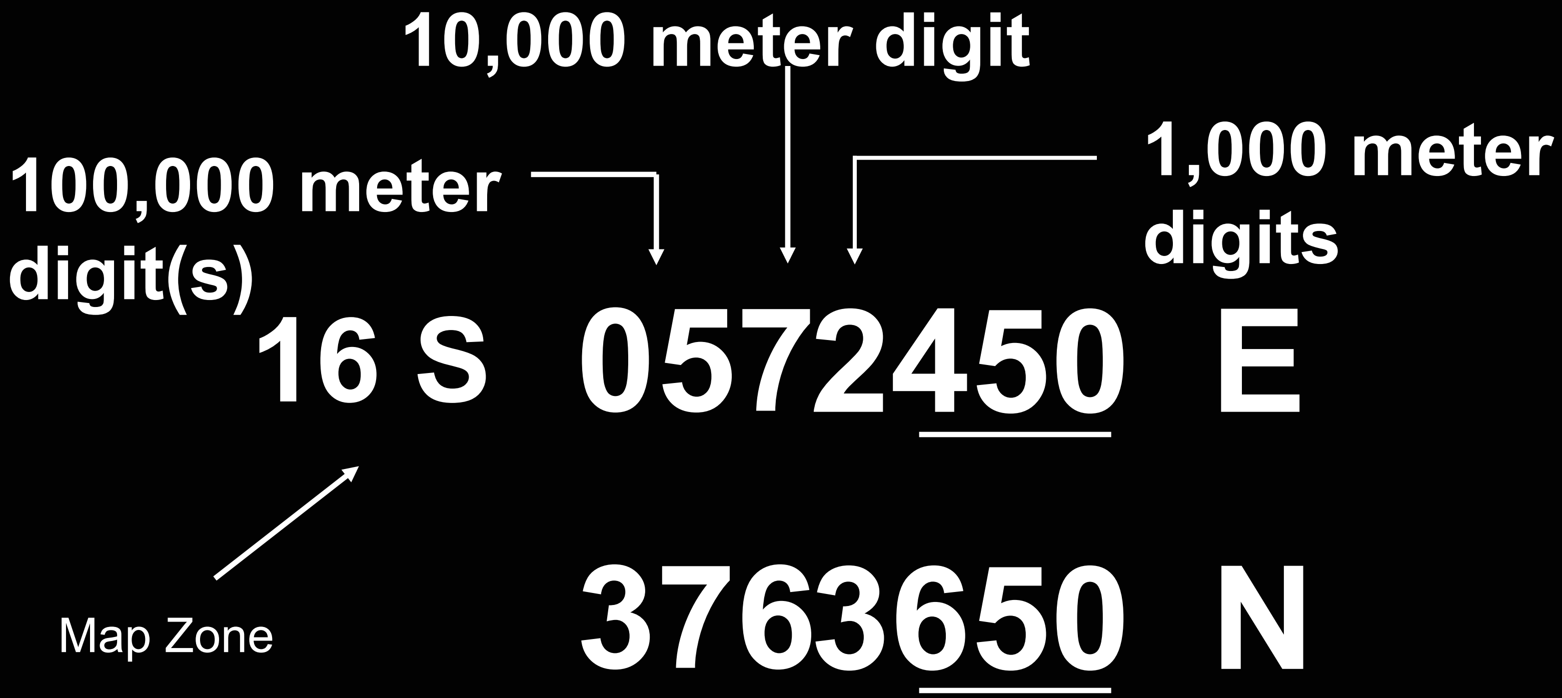
Is a 6-digit number to designate the EAST/WEST position in the grid. The grids are the widest at the equator. Since each grid has a different width, a system was created to measure the distance across a grid starting from the vertical center-line of each grid as opposed to starting from the left or right edge of a grid. The center line of each grid is called the central meridian. The central meridian is always assigned an easting value of 500,000 meters East. It is expressed as 500,000 mE. As you move west of the central meridian the easting will be a number less than 500,000. As you move to the east of the central meridian the easting will be a number greater than 500,000. An easting of zero will never occur, since a 6° wide zone is never more than 674,000 meters wide.

Northing:

The second number is called the Northing. It is a 7-digit number that designates how many meters you are north or south of the equator.


16
17
Central Meridian
500,000 mE

RANDALL'S ADVENTURE TRAINING ®
LAND NAVIGATION



10,000 meter digit

100,000 meter digit(s)

1,000 meter digits

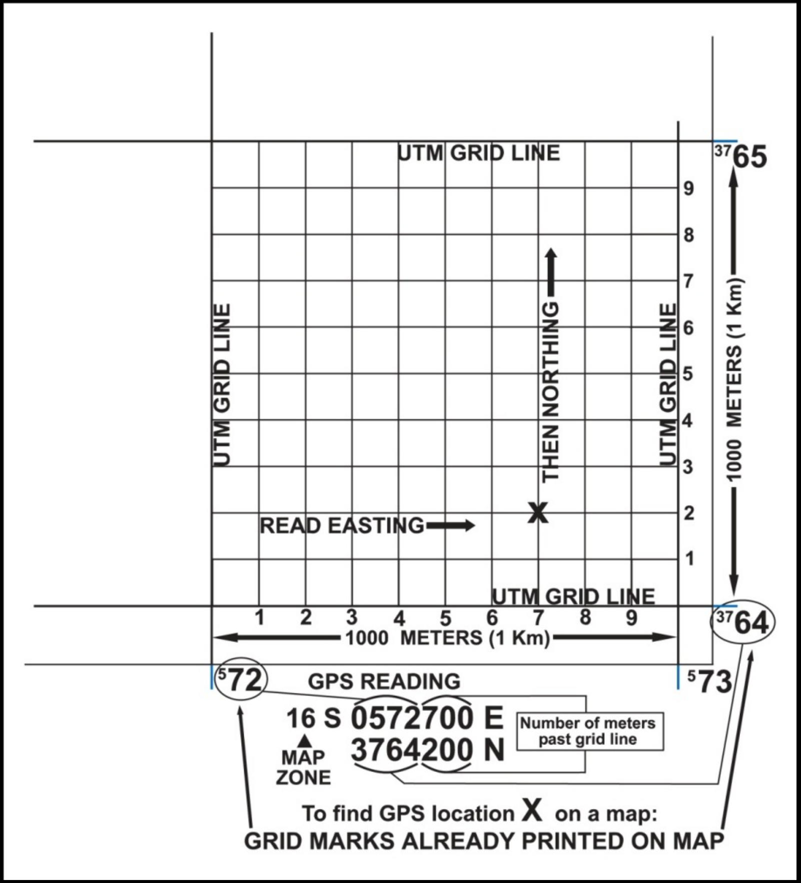
16 S 0572450 E

3763650 N

Map Zone

You only have to plot the last 3 numbers. The rest of the coordinate values are provided on the map

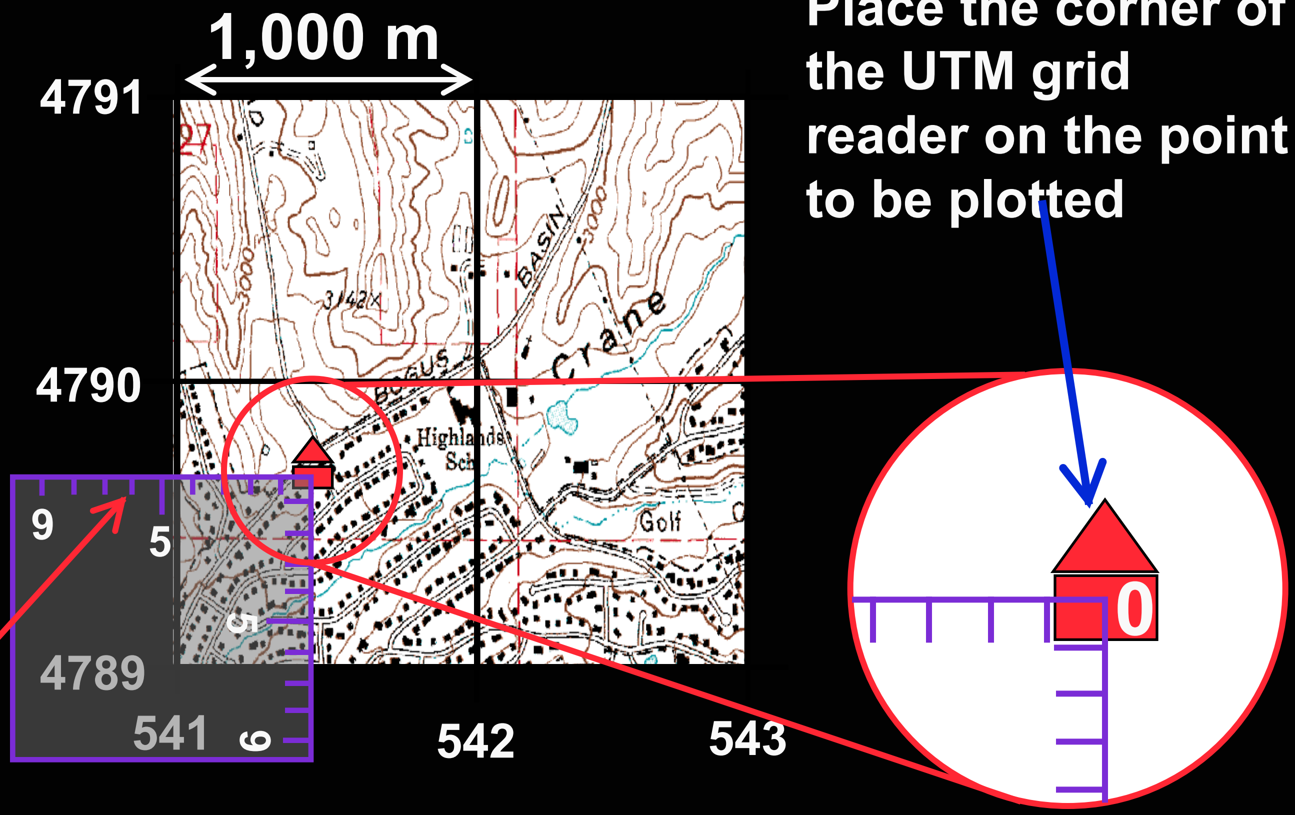
RANDALL'S ADVENTURE TRAINING ®
LAND NAVIGATION


UTM GRID LINE
3765
9
8
7
6
5
4
3
2
1
1000 METERS (1 Km)
UTM GRID LINE
THEN NORTHING
UTM GRID LINE
X
READ EASTING
UTM GRID LINE
1 2 3 4 5 6 7 8 9
1000 METERS (1 Km)
3764
572
GPS READING
573
16 S 0572700 E
3764200 N
MAP ZONE
Number of meters past grid line
To find GPS location X on a map:
GRID MARKS ALREADY PRINTED ON MAP

Read EASTING First

Then Read NORTHING

RANDALL'S ADVENTURE TRAINING ®
LAND NAVIGATION


1,000 m
4791
4790
9
5
5
4789
541
6
542
543
0
3142X
BASIN
3000
Crane
BOGUS
Highlands
Sch
Golf

Place the corner of the UTM grid reader on the point to be plotted

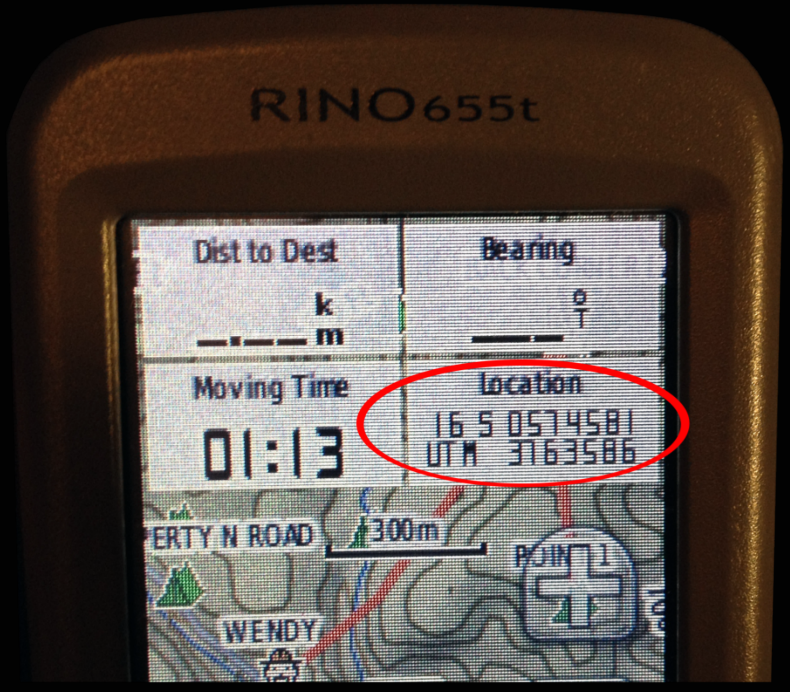
UTM grid reader

Each tic = 100 meters on this grid reader

House coordinates = 0541450mE 4789650mN

Using GPS with Map

When using a GPS to acquire an azimuth to a location, setup your GPS for Magnetic North Heading if you are not adjusting declination on your compass. Use True North Heading if your are adjusting for declination on your compass.


RINO655t
Dist to Dest
k
m
Bearing
°
T
Moving Time
01:13
Location
16 S 0574581
UTM 3163586
ERTY N ROAD
300m
POIN 1
WENDY

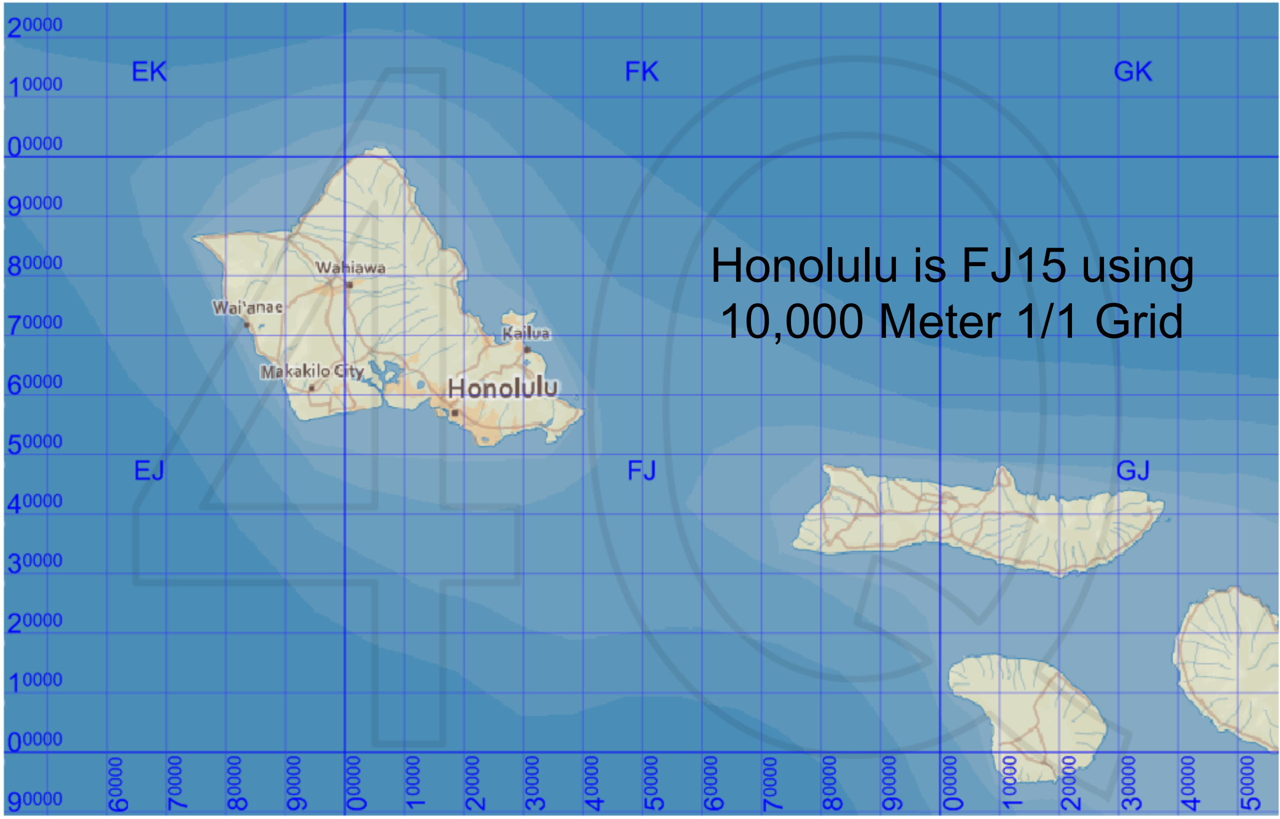
Plotting GPS to Map

1) Find current location with GPS
2) Use scale card to plot current location on the map

Plotting Map to GPS

1) Plot location on map of where you want to go with a scale card
2) Enter plotted coordinates into the GPS as a new waypoint

MGRS System


20000
10000
00000
90000
80000
70000
60000
50000
40000
30000
20000
10000
00000
90000
EK
FK
GK
EJ
FJ
GJ
Wahiawa
Wai'anae
Kailua
Makakilo City
Honolulu
60000
70000
80000
90000
00000
10000
20000
30000
40000
50000
60000
70000
80000
90000
00000
10000
20000
30000
40000
50000

Honolulu is FJ15 using 10,000 Meter 1/1 Grid

5/5 = 1 Meter, 4/4 = 10 meter, 3/3 = 100 meter,
2/2 = 1000 meter, 1/1 = 10,000 meter

Why do we not use Latitude / Longitude for Land Nav?

Communicating Location

General Location
Type Of Navigation Grid Used
Grid Location (Easting Then Northing)
Direction Of Travel If Moving

Declination

Magnetic Declination is the difference between True North and Magnetic North. A compass needle ALWAYS points to Magnetic North.

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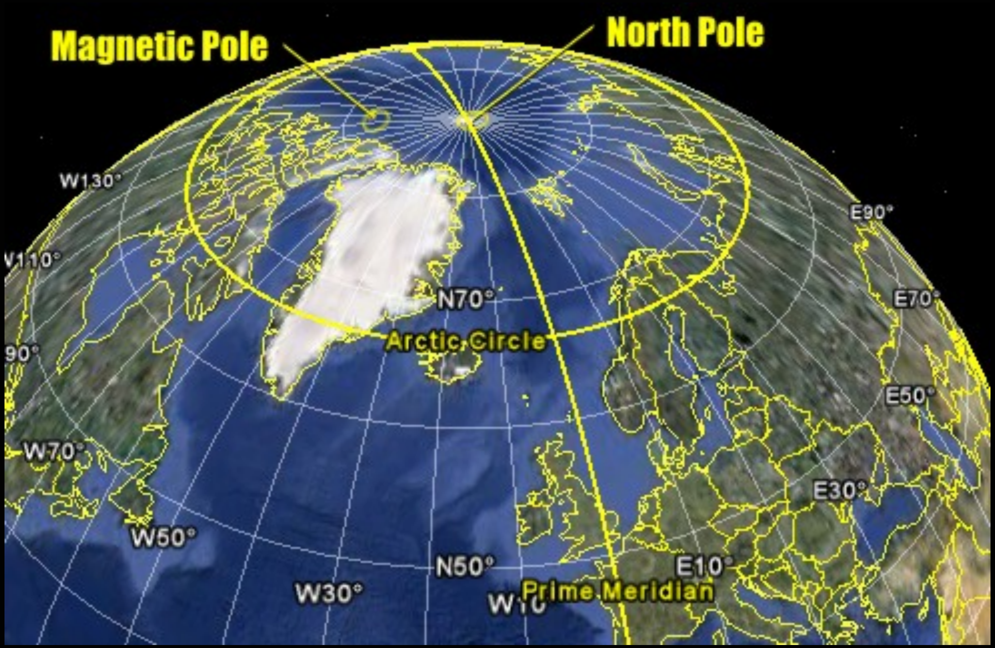
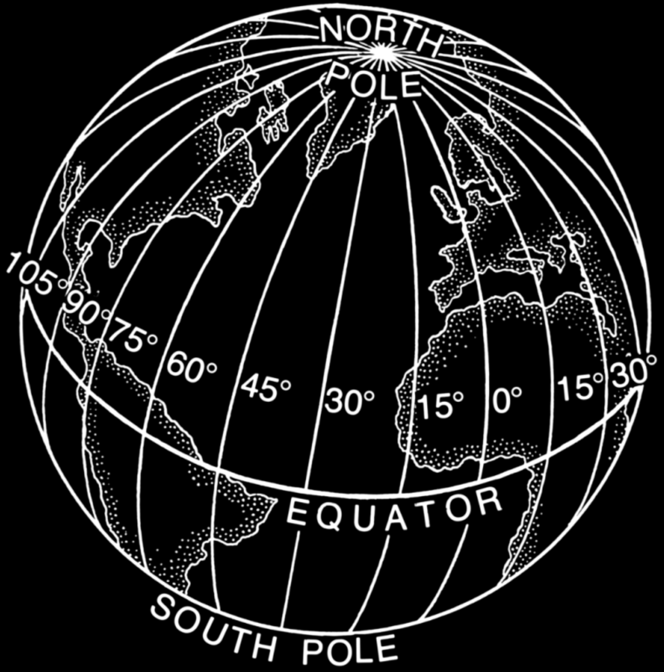
LAND NAVIGATION


Magnetic Pole
North Pole
W130°
W110°
90°
W70°
W50°
W30°
W10°
N70°
Arctic Circle
N50°
Prime Meridian
E10°
E30°
E50°
E70°
E90°

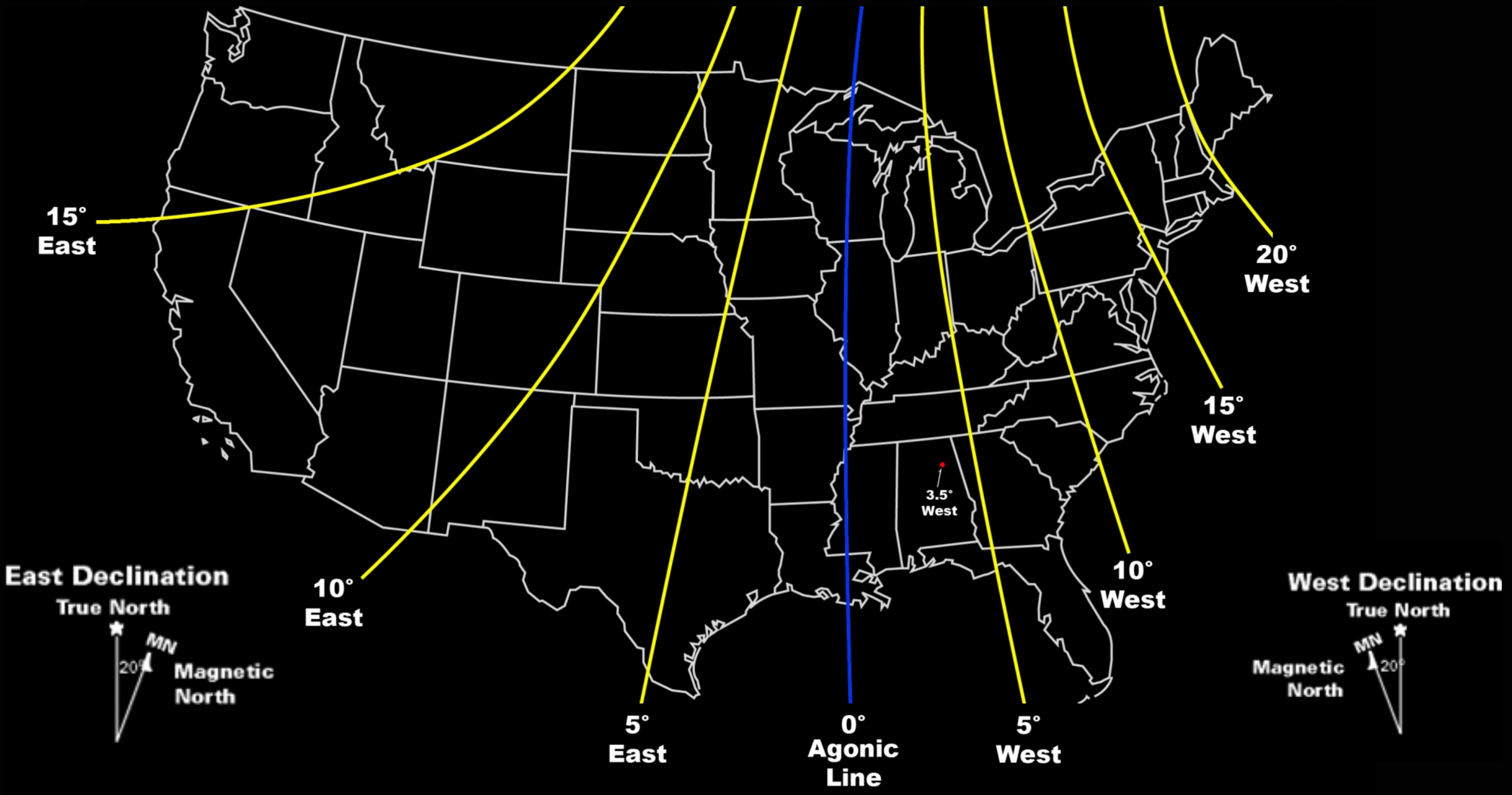
Difference in True North
And Magnetic North


NORTH POLE
105°
90°
75°
60°
45°
30°
15°
0°
15°
30°
EQUATOR
SOUTH POLE

Longitude Lines
(True North)

Magnetic North is moving approximately 40 miles per year.

Magnetic Declination

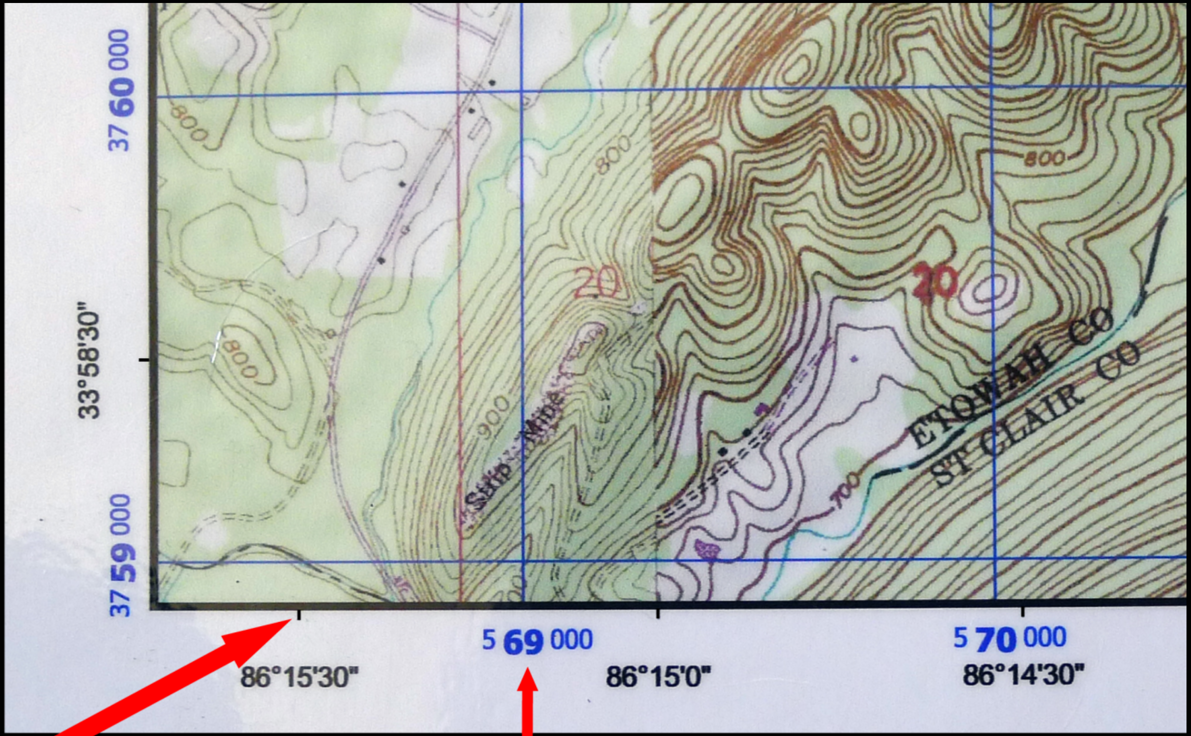

15°
East
10°
East
5°
East
0°
Agonic
Line
5°
West
3.5°
West
10°
West
15°
West
20°
West
East Declination
True North
MN
20°
Magnetic
North
West Declination
True North
MN
20°
Magnetic
North

If you do not have a compass that adjusts for declination remember to add or subtract declination to your azimuth. Add for West – Subtract for East

EAST IS LEAST - WEST IS BEST

RANDALL'S ADVENTURE TRAINING ®
LAND NAVIGATION

Depending on your map, it may printed with True North Reference lines or Grid North Reference lines



37 60 000
33°58'30"
37 59 000
5 69 000
5 70 000
86°15'30"
86°15'0"
86°14'30"
800
900
700
20
Strip Mine
ETOWAH CO
ST CLAIR CO

True North (Longitude)

Grid North (UTM Or Other Grid)

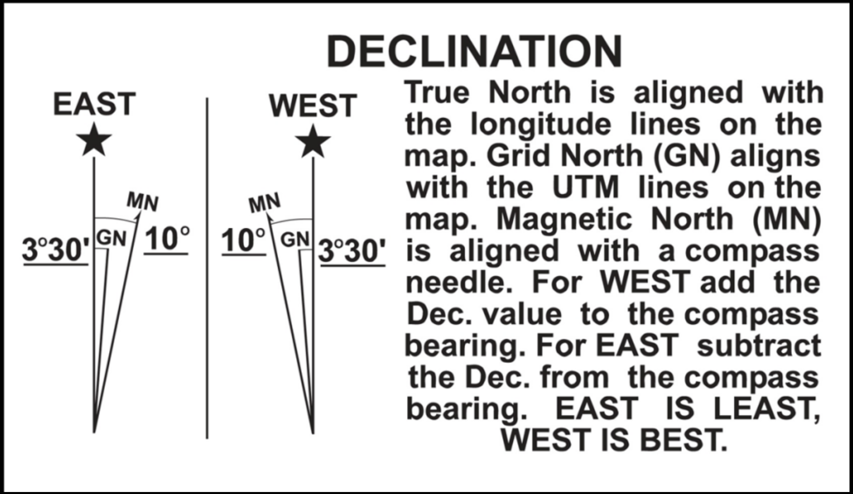
Adjusting For Declination For Map Use

Declination is the difference between true north and magnetic north when using the longitude lines as north reference.

Declination is the difference or spread between grid north and magnetic north when using the UTM grid lines as north reference.

At the bottom of your map, if the MN line is left of the True North Line it will always be West Declination. If the MN line is right of the True North Line it will always be East Declination

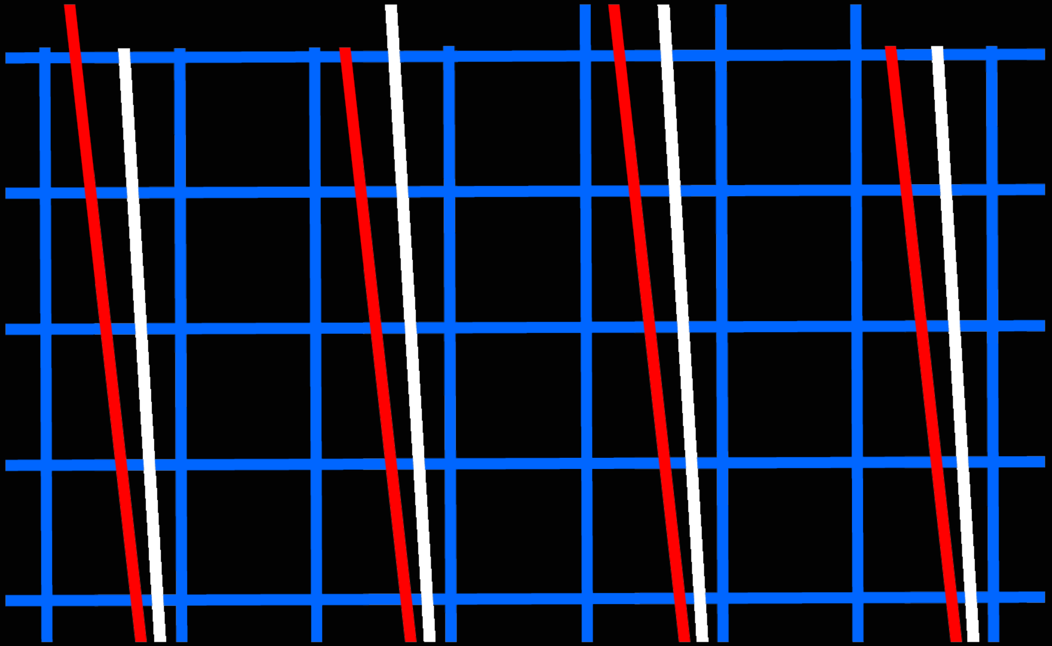
If you are using a compass that is not adjusted for declination, add the amount for west declination, subtract the amount for east declination. If your compass is adjustable for declination, set it for the north reference declination value you are using. No further addition or subtraction is required.



DECLINATION

True North is aligned with the longitude lines on the map. Grid North (GN) aligns with the UTM lines on the map. Magnetic North (MN) is aligned with a compass needle. For WEST add the Dec. value to the compass bearing. For EAST subtract the Dec. from the compass bearing. EAST IS LEAST, WEST IS BEST.

True North / Magnetic North / Grid North



Compass Needle

Magnetic North

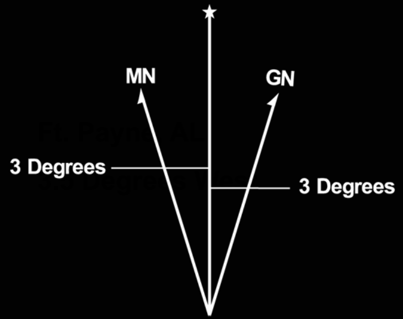
Longitude

True North

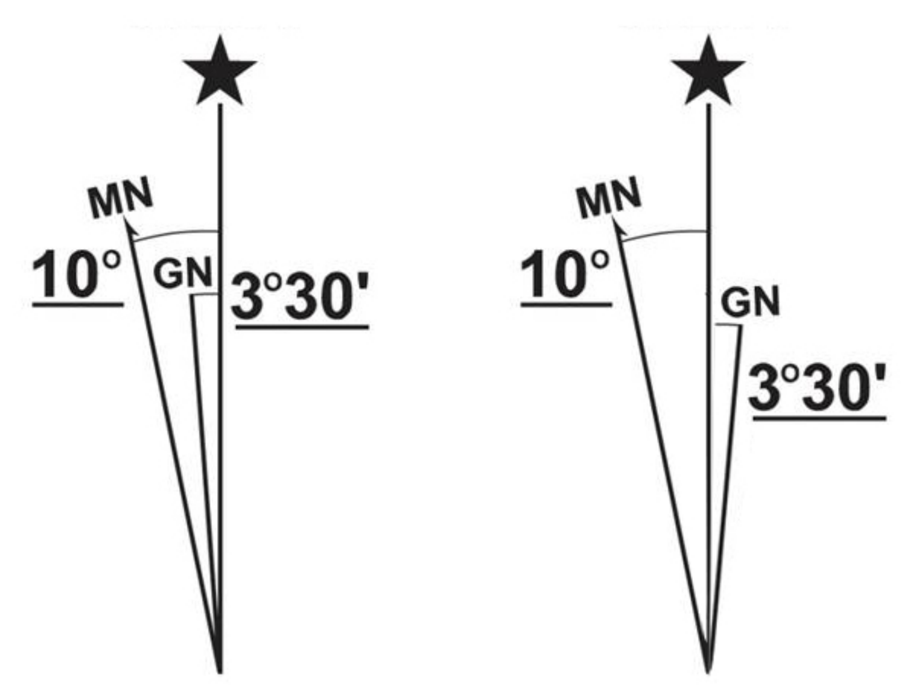
Map Grid

Grid North

If using Grid North as Reference then declination would be set to 6 degrees West
If using True North as Reference then declination would be set to 3 degrees West



RANDALL'S ADVENTURE TRAINING ®
LAND NAVIGATION


MN
10°
GN
3°30'
MN
10°
GN
3°30'

Ft. Payne, AL
3.5 Degrees West

What is our declination value for each of the diagrams to use Grid North Reference?